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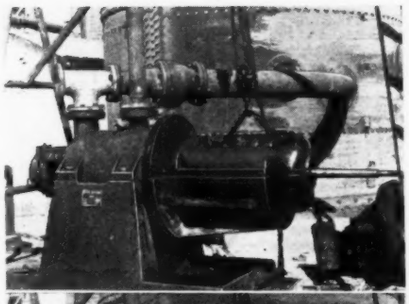
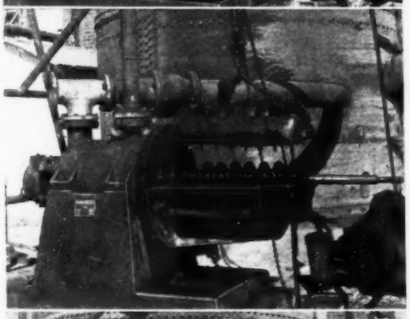
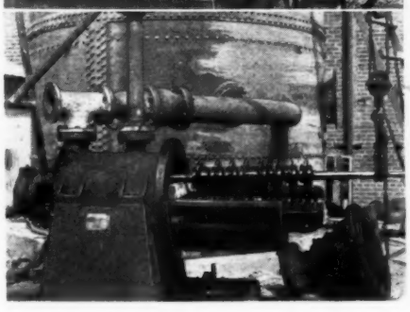


Inner Volute Case and Rotating Element being removed as a single unit. Note weight being carried on the Dismantling Tray.



Upper half of Inner Volute Case lifted preparatory to removal of completely assembled Rotating Element.



Rotating Element being lifted clear of pump. Spare Rotating Element is simply dropped into position and the pump re-assembled.

BYRON JACKSON DOUBLE-CASE HOT OIL CHARGING PUMP

. . . with simple minor bearing parts removed, and End Cover with Bearing Housing being removed. No Piping has been disturbed and the Driver has not been disconnected or disturbed. The Dismantling Tray in foreground will be found in position in illustrations below.

These pumps have gained the favor of operators because they can be so easily dismantled and reassembled in the field, without disturbing piping or drivers, and with no necessity for field work upon the Rotating Element.

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THE Petroleum Engineer • JUNE 1938 • VOLUME IX • NUMBER 9

A MAGAZINE OF METHODS FOR OPERATING MEN

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MEETINGS

Society of Automotive Engineers, Summer Meeting—June 12, 13, 14, 15, 16, and 17, White Sulphur Springs, West Virginia.

•

Pennsylvania Grade Crude Oil Association — June 16, 17, and 18, Pittsburgh, Pennsylvania.

•

American Society of Mechanical Engineers—June 20, 21, 22, 23, and 24, St. Louis, Missouri.

•

American Society for Testing Materials, Annual Meeting—June 27, 28, 29, 30, and July 1, Atlantic City, New Jersey.

•

California Natural Gasoline Association—July 7, Richfield Building, Los Angeles, California.

•

West Virginia Oil and Natural Gas Association—July 27 and 28, Charleston, West Virginia.

•

American Chemical Society—September 5, 6, 7, 8, and 9, Milwaukee, Wisconsin.

•

American Association of Petroleum Geologists, Mid-Year Meeting—September 27, 28, 29, 30, October 1, and 2, El Paso, Texas.

•

Society of Automotive Engineers, National Regional Fuels and Lubricants Meeting—October 6 and 7, Tulsa, Oklahoma.

•

American Institute of Mining and Metallurgical Engineers, Petroleum Division—October 6 and 7, San Antonio, Texas.

•

National Stripper Well Association, Annual Meeting—October 18, Tulsa, Oklahoma.

•

Oklahoma Stripper Well Association, Annual Meeting — October 18, Tulsa Oklahoma.

•

American Petroleum Institute, 19th Annual Meeting—November 14, 15, 16, 17, and 18, Stevens Hotel, Chicago, Illinois.

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The Course of Oil

By K. C. SCLATER

Unnecessary Wells and Well-Spacing

It has been estimated by a committee of competent engineers that during 1936 in excess of $85,000,000 was spent on drilling unnecessary wells in the United States. By unnecessary wells is meant wells that were not really needed for obtaining efficient maximum ultimate recovery from the reservoir into which they were drilled.

Expenditures for excessive drilling are a grievous economic loss to the industry. Not only that, excessive drilling in recent years has caused many of the ills now besetting the producer.

A satisfactory solution of this problem must be found in proper well-spacing, which involves a consideration of reservoir conditions and acreage. Important legal aspects of well-spacing must also be considered.

Concerted action toward eliminating this problem may be in the offing. Last month at Wichita, two special A.P.I. committees on well-spacing study submitted summary reports on the legal and engineering aspects of the problem.

The legal sub-committee reported that:

"The evil consequences to the oil and gas industry and to the general public which flow from the drilling in great numbers of unnecessary wells call for remedial action on the part of the industry to the extent that this is legally possible, and on the part of the appropriate regulatory bodies of the several oil states.

"There is very little that the individual operator can do to remedy the situation except to refrain from becoming an aggressor in precipitating an unnecessary drilling program. If his neighbors should drill unnecessary wells, he is forced to drill to protect himself from drainage and to perform the obligations of his lease, unless he is granted such an adjustment in his allowable production as will enable him to produce his fair share of oil and gas without drilling more wells on his lease.

"For legal reasons, those in the industry hesitate to solve the problem by concerted action—that is, by agreements not to drill what are thought by them to be unnecessary wells. With the spacing patterns prescribed for them, and their allowables fixed, by governmental authorities, they must oftentimes either drill down to the most dense pattern or lose out in the race.

"In these days of regulated drilling patterns and regulated production of oil and gas, the onus of prescribing and enforcing proper orders, rules, and regulations to prevent the drilling of unnecessary wells largely rests with the regulatory agencies of the several oil-producing states. The problems can largely be solved by proper regulation. It is fair and proper that we point out several ways in which the conservation agencies of the several oil-producing states may help to remedy the situation. Some practical suggestions follow:

"(a) Fix a top allowable for each field at such a point that physical waste will be avoided and the reasonable market demand will not be exceeded.

"(b) Prescribe a uniform drilling pattern for each field as soon as possible after production is obtained and grant no exceptions to such a pattern unless localized conditions in the field definitely require that this be done in order to prevent waste. If an operator be granted such an exception, then so adjust his allowable as to enable him to produce no more than his fair share of the oil and gas.

"(c) Require pooling of small or irregularly shaped tracts on a fair basis in order to preserve, so far as possible, a uniform spacing pattern.

"(d) So adjust the allowable production between wells and separate properties in the field that after an operator has drilled such number of wells on his property as will enable him reasonably to produce the recoverable oil and gas in place under his land, he will not be required to drill additional wells in order to produce his fair share of oil and gas and to prevent unreasonable drainage which is not equalized by counter-drainage through his wells.

"(e) In prescribing the allowable for each well or property the regulatory agencies should not give undue consideration to wells and potentials unless the statutes specifically require that this be done.

"(f) If the law *requires* that production be allocated on a well-potential factor, or any combination of factors giving great value to mere wells or their potentials, then strictly adhere as nearly as possible to a uniform spacing pattern, to the end that relatively uniform withdrawals from the reservoir may be had so far as practicable.

"(g) The regulatory agencies should establish an appropriate proration unit in each field and, regardless of the number of wells drilled on such units, should allocate production between such units so as to obtain ratable production, to the end that each operator will obtain his fair share of the recoverable oil and gas from the field without the necessity of drilling unnecessary wells."

The other special study committee on well-spacing, composed of a group of prominent engineers, prefaced their recommendations with an outline of engineering principles on production of oil and gas from a reservoir. Some of these principles and recommendations are:

"It is generally agreed that the maximum rate at which a pool can be produced efficiently and economically can be determined.

"To gain the greatest ultimate recovery, ratable withdrawals from the reservoir must be maintained.

"The rate of withdrawal materially affects the drainage area of a well. Given the former, engineers may, within reasonable limits, determine the latter. * * *

"The same or greater efficiency of recovery can be obtained by wider spacing at lower rates of flow per acre than by close spacing at excessive rates of flow per acre.

"Well density, within reasonable limits, is not a factor affecting ultimate recovery when ratable withdrawals by the owners of the oil in place is observed in a pool. * * *

"In view of the above principles outlined, it is recommended the maximum rate of a pool's production should be specified.

"An allocation unit should be adopted which is sufficiently large to prevent the compulsory drilling of unnecessary wells. * * *

"The method of distribution to the allocation units should assure ratable withdrawal from the reservoir and no drainage across property lines, which is not equalized by counter drainage."

Recommendations submitted in these reports should have the earnest consideration of all state officials charged with the regulation of oil and gas production.

« « HIGHLIGHTS IN OILDOM » »

Some Objection to Kansas Potential Plan

Some objection has developed to the Kansas Corporation Commission's plan for determining potential of oil wells by use of the composite withdrawal decline curve. At a recent hearing of the commission in Wichita, W. E. Stanley, representing the Continental Oil Company, asserted that the plan operates to prevent ratable taking and produces waste in pools because of assumed potentials. He suggested a trial balance plan be adopted to obtain early estimates of current monthly allowables. Under this plan crude oil purchasers would file written nominations with the commission in advance of the regular monthly allowable hearing. After receiving the nominations the commission would fix the allowables of the various fields as is done at present and purchasers notified of the tentative allowable. At the monthly hearing any adjustment in market demand could be made and a permanent allowable established, Stanley explained.

Stanley's testimony was given in connection with Continental's application before the commission relative to fixing allowables in the Geneseo pool of Rice County.

●

Study East Texas Well Pressures

A report issued by the engineering department of the Texas Railroad Commission reflects the trend of bottom-hole pressure in the East Texas oil field. The report states that on June 10, 1933, the average bottom-hole pressure for the field was 1240 pounds. The field had been producing oil since December, 1930, and had produced 19,070,389 barrels. On May 8, 1938, the average bottom-hole pressure of the field had declined to 1118.26 lb., a total decline of 121.74 lb. during a period of approximately five years. Total production had increased to 810,328,081 barrels.

The average bottom-hole pressure decline from June 10 to July 10, 1933, was 39 pounds. The average bottom-hole pressure decline per 1,000,000 bbl. of allowable was 2.045, the most rapid rate of decline recorded since pressure tests were begun. It was during this period that the allowable averaged 635,680 bbl. per day, the greatest allowable recorded. The effect of withdrawal on pressure was indicated by results the following month when the allowable averaged only 569,775 bbl. per day and average bottom-hole pressure increased 39 lb., the amount lost the month before.

The average increase in bottom-hole pressure per 1,000,000 bbl. of allowable from July 10 to August 10, 1933, was 2.445 lb., thus the average increase exceeded the average loss for the previous month.

Declining allowables during the last four months have retarded the pressure decline. From January 8 to February 8, 1938, allowables averaged 446,962 bbl. per day, and the bottom-hole pressure declined at the rate of 0.510 lb. per 1,000,000 bbl. of allowable oil. The month preceding the decline averaged 0.762 lb. per 1,000,000 bbl. of allowable, the daily allowable being 475,015 barrels.

●

Oppose Acquisition of California Tidelands by Govt.

California apparently has won its fight to prevent the Federal Government from claiming title to its tidelands. On May 17th the Judiciary Committee of the House of Representatives approved legislation to permit the United States to acquire for purposes of national defense oil reserves off the California coast between low water and the three-mile limit. When the action of the committee became known immediate steps were taken to prevent further action on the part of Congress.

A group of oil men and state officials met and chose a committee of 12 to conduct the campaign against the proposed legislation. Acquisition of California tidelands by the Federal Government was opposed on the following grounds: (1) It is an unwarranted encroachment on states' rights; (2) it nullifies court decisions dating from 1873, which have held that the tidelands off California have belonged to the state, and were transferred to the state upon its admission to the Union; (3) it is a matter of more far reaching importance than its immediate effect upon the California oil industry; (4) titles to all filled-in lands along the coast would be clouded, as well as titles to all riparian lands bordering navigable streams; (5) it is but the first step in similar procedure against tidelands in other states.

A committee was sent to Washington and as a result of its work the proposed legislation, known as the Nye resolution, has been sent to the Rules Committee of the House of Representatives, and it is the general opinion that no action will be taken in the matter at the current session of Congress.

●

State Can Withhold Mineral Rights Court Rules

The State of Michigan is within its rights in withholding mineral, oil, and gas rights on public lands deeded to homesteaders, the Michigan Supreme Court has ruled in upholding a decision of the Gladwin Circuit Court. The two decisions resulted from an action brought by Mrs. Lena L. Rathbun, who sought to enjoin the state from leasing mineral rights on an 80-acre tract homesteaded by her father-in-law in 1921. She contended that the Public Domain Act is in conflict with the General Property Tax Law and, therefore, unconstitutional.

In making its decision the Supreme Court said, in part:

"While the General Property Tax Law makes provision for the assessment, levy, collection, and enforcement of property taxes and the foreclosure of tax liens, it also provides for the acquisition by the state of absolute title to the lands for delinquent taxes and for the sale of such property originally through the commission of the state land office, then through the public domain commission, and thereafter through the Department of Conservation.

"These various statutes, the General Tax Law, an act for the appointment of a commission of inquiry, the Public Domain Act and the Conservation Act, are not contradictory. The Public Domain Act, providing for the reservation of oil, gas, coal, and mineral rights in all lands owned by the state infringes upon no other statute and contravenes no provision of the constitution in this regard."

●

Plan Extension of Poland's Petroleum Laws

Since the restoration of its independence almost 20 years ago, Poland has had no uniform system of oil-mining legislation. As a result, oil-producing activities are still gov-

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erned by an Austro-Hungarian law of 1908, based on the principle that ownership of the deeper geological strata rests with the owner of the surface. The Polish government views with concern the progressive decline in production of petroleum, a product in which the country has been self-sufficient but may not remain so should exhaustion of existing fields proceed at the rate of the last two or three years and no new fields be discovered. To encourage the search for new fields, the Ministry of Industry and Commerce last year prepared a bill that, though not altering the old Austrian principle of ownership, offers definite incentives to private interests. The bill is expected to become a law during a special session of the Polish Parliament convening this month.

Briefly, the main provisions of the proposed law are as follows: It will be subsidiary to, and not in substitution of, present legislation. Although intended primarily to increase production of crude petroleum, it will apply to all natural deposits of bituminous minerals. Exploration is to be permitted without the necessity of obtaining mining rights from the landowner, these being accorded if necessary by an official mining board and the landowner paid a fixed percentage of the value of any petroleum produced, besides twice the surface's productive value. To prevent unprofitable individual installations acreage will be limited and mining rights will be possible of extension to a total of 50 years. Finally, fees will be collected from producers with which will be established an institution for scientific investigation of oil mining.

●

Saturday Shut-Downs May End for Texas Fields

After the Texas Railroad Commission had scheduled a hearing for June 20th at Austin to consider July production quotas, Commissioner E. O. Thompson stated that Saturday shut-downs probably could be terminated "if consumption picks up as it normally is expected to do." At the same time indications were given that the Sunday shut-downs probably would continue indefinitely. Thompson stated further that it could not be said definitely at this time whether June would see the last of the Saturday shut-downs, but pointed out that they had been ordered as an emergency measure and, he said, the menace of oversupply is not nearly so great as it was a month ago.

●

To Explore Sub-Andean Area of Bolivia

Bolivia and Brazil have entered into a treaty whereby the two countries are to cooperate in conducting geological surveys of exploration operations in the sub-Andean area of Bolivia, extending from the Parapeti River northward. By the terms of the agreement, producing companies, after internal requirements of Bolivia are satisfied, are to supply the Brazilian market. Surplus oil is to be moved across Brazil and exported. Both countries are to permit the laying of pipe lines within their boundaries. Bolivian oil passing through Brazil will not be subject to fiscal taxes and railroad rates will not be higher than those applying to oil from other sources.

To Extract Oil From Shale in Bahia, Brazil

Approximately 60 miles down the coast from Bahia, Brazil, is an extensive district rich in petroleum shale, reports Consul Robert Janz, Bahia. This area surrounds the Bay of Camamu, near the city of Marahu. According to a recent decree, the acting governor of the State of Bahia is authorized to spend $340,000 to establish an oil extraction plant at Marahu. The erection of the plant and its initial operation will be carried out by the German firm of Julius Pintsch Kommanditgesellschaft. The contract made between the German company and the State specifies that the former will sell to the government sufficient machinery for the operation of the plant, and will provide engineers for its operation, their salaries to be paid by the government.

●

To Appeal Decision of Mexican Court

A decision of the first district court of Mexico, which ruled that President Cardenas acted within the constitution when he expropriated their oil properties last March 18th, will be appealed to the Supreme Court of Mexico by 17 American and British companies. Constitutionality of the expropriation decree was upheld in an opinion by Judge Manuel Bartlett, who rejected a plea by the petroleum companies for an injunction nullifying the confiscation of their properties. Judge Bartlett said: "Article 27 of the constitution provides for just indemnification." The judge ruled, however, that the Mexican government had been at fault in seizing bank deposits, archives, and correspondence of the companies and ordered that the cash and records be returned.

The constitutionality of the expropriation law invoked by Cardenas was upheld, Judge Bartlett said, "insofar as it affected the properties actually appertaining to production, exploitation, and distribution of oil."

●

Kansas Adopts Well-Spacing Program

The Kansas Corporation Commission, on June 14th, adopted a well-spacing rule for the state and by its action the petroleum industry came one step nearer a unified program of well-spacing, a proposal made by the American Petroleum Institute in 1927. Oklahoma and Texas already have adopted well-spacing rules.

The Oklahoma Legislature, in 1935, granted the State Corporation Commission power to promulgate a well-spacing rule, and recently in the Patterson-Amerada-Stanolind case the Supreme Court held that such a restrictive program was legal and proper in the orderly development of oil and gas leases, and a step toward the elimination of waste.

The Texas Railroad Commission's Rule 37 governs well-spacing in that state. The State Supreme Court has upheld the ruling. The Texas Railroad Commission has not deemed it advisable to apply the rule to fractional leases, otherwise it is similar to the Kansas and Oklahoma rules.

The new Kansas rule provides that a well shall not be drilled on less than ten acres or more than 20 acres, but includes a provision that in event the property owner has less than ten acres and cannot produce or protect himself, then he may drill on the fractional tract, but his production will be prorated according to the area of his tract.

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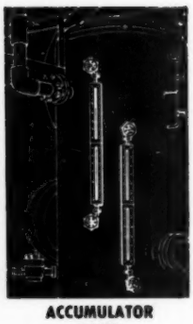

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● The sketches show only a few of the many important applications for Penberthy Reflex Gages in oil refineries and natural gasoline plants. As a matter of fact, Penberthy Reflex Gages are preferred wherever a liquid level must be easily and positively visible . . . when that liquid is under pressure or at high temperature (or both).

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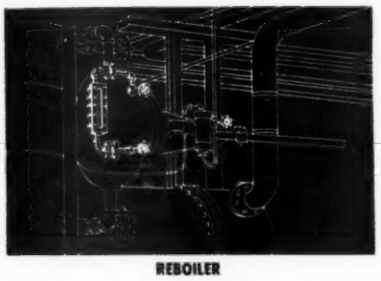

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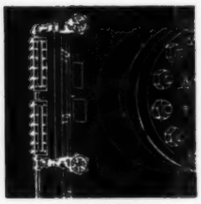
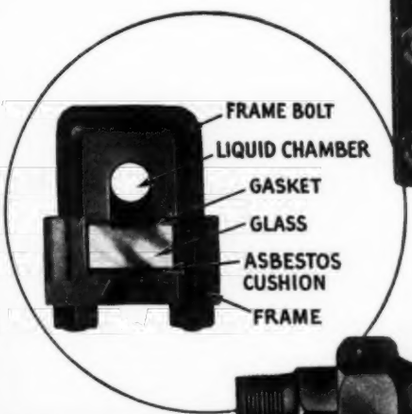
VAPOR SEPARATOR

CRACKING STILL



STABILIZER



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Latest Activities In The Oil Fields

THOMPSON'S No. 1 Fisk, in NWC SE 33-3e-8n, Fayette County, Illinois, extended the Beecher City pool two miles when it drilled 20 ft. of saturated Benoist sand and shut down to wait for pipe-line connections. Jarvis' No. 1 Yakey, in SE 6-3e-7n, a three-mile farther extension, drilled 26 ft. of highly-saturated Benoist sand.

●

Northern Natural Gas Company's No. 1 A. J. Daner, in Section 237, Block B-2, H. & G. N. Survey, Carson County, Texas, ten miles southwest of Pampa, opened a new pool six miles from the nearest producing area when it flowed 210 bbl. of oil in 11 hours. The well was drilled into granite wash at a depth of 3100 ft. and total depth is 3105 feet. An estimated 1,000,000 cu. ft. of gas per day accompanied the oil.

●

Magnolia Petroleum Company's No. 1 Sexton, in NWC SE 32-23n-9w, Webster Parish, Louisiana, produced 124 bbl. of 54.6-deg. distillate in a 12-hour gauge to open a new deep-producing zone in the Shongaloo field. The oil was accompanied by 2,331,000 cu. ft. of gas. The well was drilled to a total depth of 10,462 ft. and plugged-back, 7-in. casing set at 9464 ft., and perforated from 8990 to 9010 feet. The well flowed through 2½-in. tubing at a pressure of 300 lb., casing pressure being 625 pounds.

●

Sinclair Prairie Oil Company's No. 1 J. M. Best, in the Thomas Toby Survey, 13 miles northeast of Gainesville, Cooke County, Texas, opened another North Texas deep field. Begun as an Ellenburger (Arbuckle) test, the well is to be completed in the Deese (Strawn) sand from which it produced 37-deg. gravity oil at a rate estimated to be 500 bbl. per day. Nine-in. casing is set at a depth of 4886 ft., and the producing sand was drilled from 4887 to 4900 feet.

Stanolind Oil and Gas Company's No. 1 Pardee Lumber Company, in SWC NE 36-21n-10w, Webster Parish, Louisiana, flowed at the rate of 20 bbl. of 39-deg. gravity oil per hour from the Bodcaw sand of the Lower Marine series at a depth of 8010 to 8030 feet. The well is about two miles south and east of the nearest gas-distillate wells in the Cotton Valley field, and is the first oil well in the Bodcaw sand. Total depth of the well is 8642 ft., 7-in. casing being set and cemented at 8607 ft. to exclude the gas and distillate in the upper part of the formation. The well was immediately shut-in waiting for storage.

●

Sinclair Prairie Oil Company's No. 1 Crews, in SW SW NE 27-16-1e, four miles from Meridian, Logan County, Oklahoma, was being deepened after producing at the rate of about 250 bbl. per day from Wilcox sand at a total depth of 5215 feet. Nine-in. casing is set in the well.

●

Perry Thayer et al's No. 1 Soderstrom, in SW SW NE 21-17s-13w, Barton County, Kansas, obtained the first Arbuckle lime production in the Hoisington pool when it swabbed 250 bbl. of oil in 24 hours from a total depth of 3462 feet.

●

W. A. Delaney's No. 1 Bugher, in SE SE SW 12-7n-2w, in the Noble district of southern Cleveland County, Oklahoma, flowed 1346 bbl. of oil and 853 bbl. of salt water through tubing during a 24-hour test. Total depth of the well is 7682 feet.

AVERAGE CRUDE PRICES

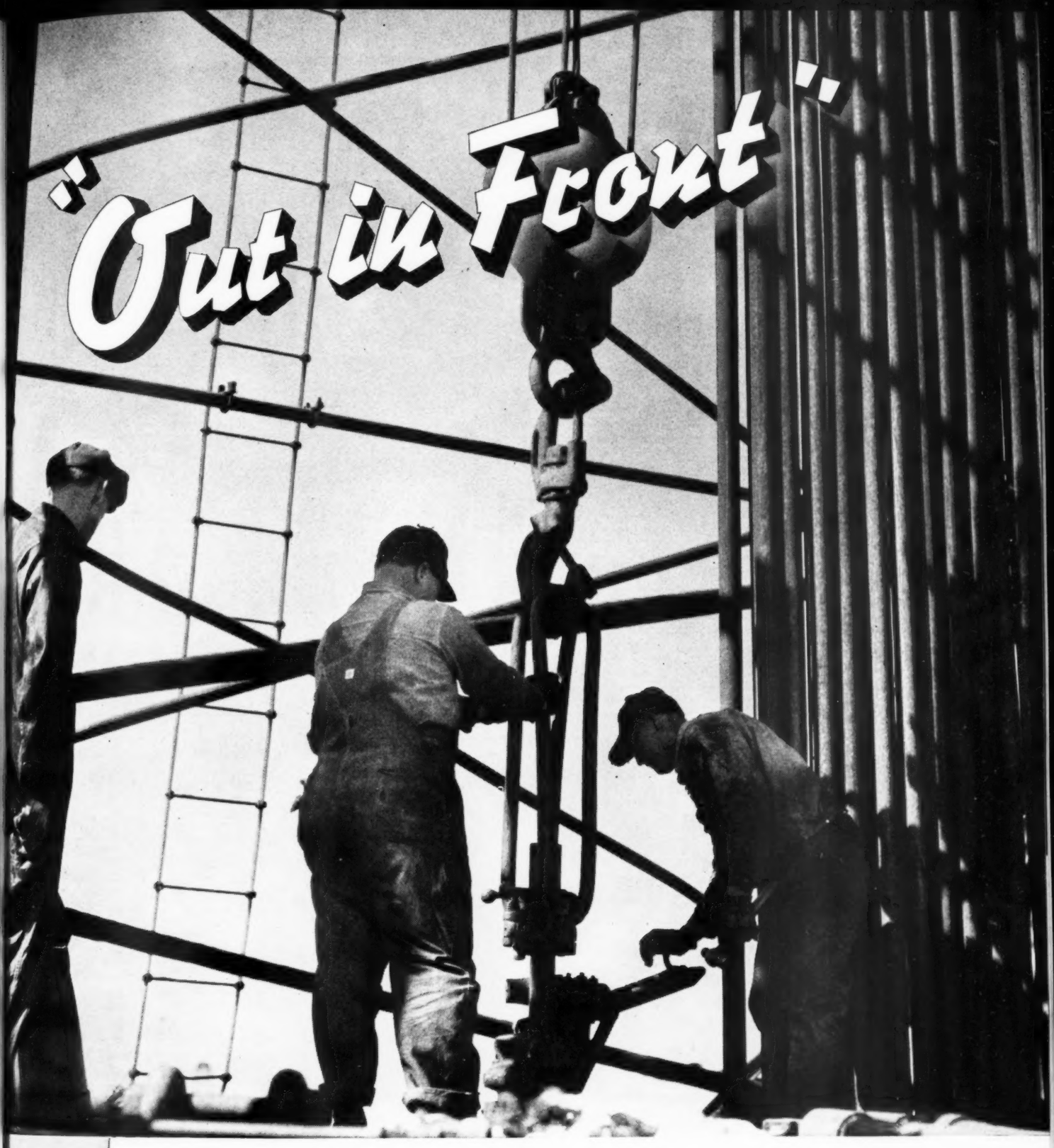
California	
Kettleman Hills	$1.19-1.43
Playa Del Rey	.80-1.16
Coalinga	.70- .90
Signal Hill	.80-1.21
Montana	1.35
Wyoming	.97-1.30
Colorado	1.12-1.18
New Mexico	.78-1.08
Texas	
North Central	.96-1.20
Panhandle	.91-1.08
West Texas	.78-1.08
Gulf Coast	.95-1.41
Darst Creek	1.09
East Texas	1.35
Talco	.73
Kansas	.98-1.30
Oklahoma	.98-1.30
Arkansas	.90
Louisiana	
Rodessa	$ .91-1.25
Gulf Coast	.84-1.41
North Louisiana	.90-1.22
Illinois	1.35
Kentucky	1.40
Indiana	1.12
Ohio	
Lima	1.25
Michigan	1.27
Pennsylvania	
Bradford	2.05
Southwest	1.71
Eureka	1.65
Buckeye	1.55
Corning	1.27
West Virginia	1.67
Canada	2.10-2.17

DAILY AVERAGE CRUDE OIL PRODUCTION

Data Supplied by A.P.I.

(Figures in Barrels)

	B. of M. Dept. of Int. Calculations (June)	Week Ended June 4, 1938	Week Ended April 30, 1938	Week Ended June 5, 1937
Oklahoma	508,300	440,500	473,900	642,350
Kansas	172,300	138,200	117,750	199,950
Panhandle Texas		60,050	70,700	85,200
North Texas		72,350	77,300	73,150
West Central Texas		27,600	29,650	33,050
West Texas		178,850	197,500	201,850
East Central Texas		95,250	103,250	126,050
East Texas		363,250	433,200	463,250
Southwest Texas		204,950	234,400	223,700
Coastal Texas		187,450	206,700	207,300
TOTAL TEXAS	1,329,300	1,189,750	1,352,700	1,413,550
North Louisiana		76,300	76,700	79,000
Coastal Louisiana		181,400	183,900	167,600
TOTAL LA.	250,000	257,700	260,600	246,600
Arkansas	48,300	43,300	54,550	28,100
Eastern	145,400	147,500	145,700	120,050
Michigan	54,000	54,750	52,100	44,400
Wyoming	49,700	51,400	46,350	50,850
Montana	12,700	14,850	13,850	15,200
Colorado	5,000	4,100	3,650	3,550
New Mexico	108,300	90,300	106,000	112,150
TOTAL EAST OF CALIF.	2,683,300	2,432,350	2,687,150	2,876,750
California	650,000	675,600	709,000	661,400
TOTAL U. S.	3,333,300	3,107,950	3,396,150	3,538,150



OUT IN FRONT . . . with *Inhibited* Acidizing

Right now, thousands of oil producers are congratulating themselves on their decision to take no chances with "raw" acid but to let Dowell do the job right with Dowell *Inhibited* Acid.

Raw acid dissolves limestone—but not any faster or better than Dowell *Inhibited* Acid.

But, raw acid also dissolves iron—it eats away on tubing, casing and equipment. Long after the treatment is over its destructive action is at work piling up a ruinous bill of damage.

Halting corrosive action of hydrochloric acid on metal through the addition of an "inhibitor" was Dowell's first great contribution to chemical well treating. It is, fundamentally, what has put Dowell "out in front" with thousands of operators who are unwilling to gamble, and lose.

Stay "out in front" with Dowell—a service based on scientific treating with sound, effective materials.

NEW! DOWELL "XR" ACID

The Sustained Action Acid

Dowell's latest achievement—a new principle of acid action. Dowell "XR" Acid is kept live till it travels far into the pay zone. Get the facts on Dowell "XR." Information at all Dowell stations.

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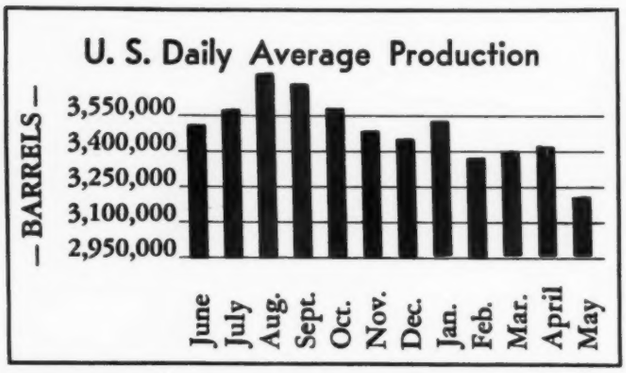
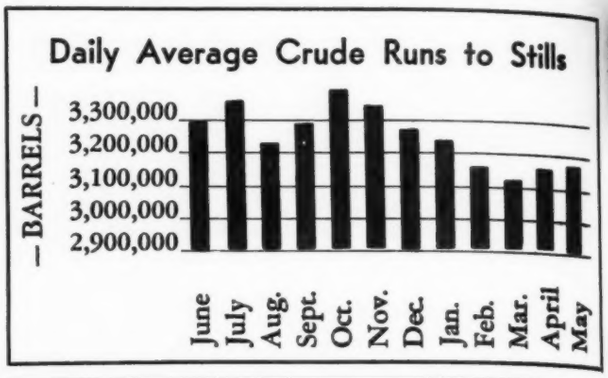
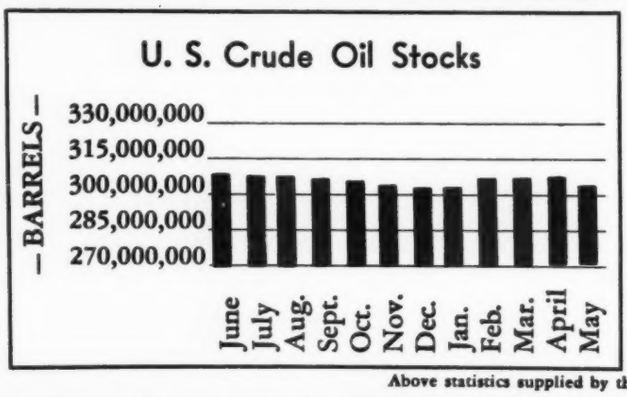
General Office: KENNEDY BUILDING, TULSA, OKLA.

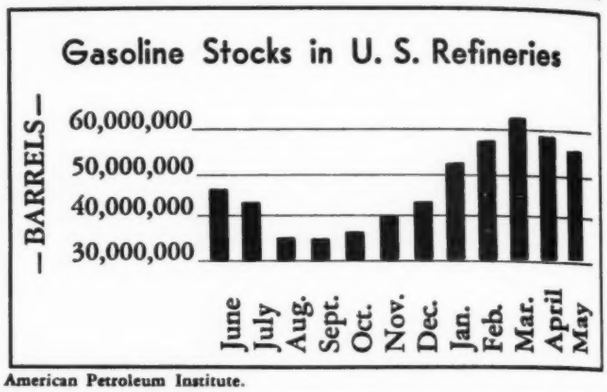
OIL AND GAS WELL CHEMICAL SERVICE

Summary of Petroleum Statistics and Field Activities









Above statistics supplied by the American Petroleum Institute.

Summarized Operations in Active Fields for May, 1938

Fields	Completions	Producers	Rigs	Drilling Wells	Depth of Production	No. Casing Strings	Gravity of Oil	Type of Tool Used
TEXAS								
East Texas	183	183	35	102	3500-3700	2	40	Rotary
Duval County	69	48	6	22	1554-2900	2	22	Rotary
Ector County	74	74	17	91	3675-4377	2 and 3	32-36	Rot.-Cab.
Panhandle	59	59	42	145	1700-3900	2	40	Rotary
Refugio County	18	18	2	9	4900-5900	2	38	Rotary
Nueces County	40	29	10	34	3922-5878	2 or 3	21-54	Rotary
Winkler County	23	23	6	18	2850-3450	2 and 3	30-38	Rot.-Cab.
Talco Field	4	4	1	5	4230-4361	2	16-24	Rotary
K. M. A. Field	122	111	17	117	3730-3935	2	42-43	Rot.-Cab.
OKLAHOMA								
Oklahoma City	9	9	3	12	6450-6682	3	39	Rotary
Fitts Pool	40	34	4	10	1800-4488	2 or 3	38	Rotary
KANSAS								
Russell County	16	14	6	25	2926-3435	2 and 5	32-37	Rot.-Cab.
Rice County	11	8	4	20	3222-4085	2 and 5	42-48	Rot.-Cab.
Barton County	29	19	4	20	3290-3518	2	39-42	Rot.-Cab.
LOUISIANA-TEXAS-ARKANSAS								
Rodessa	24	24	6	26	5950-6450	3	39	Rotary
ILLINOIS								
Central Illinois	125	114	31	164	2950-4100	2	36-38	Rot.-Cab.
NEW MEXICO								
Lea County	24	22	12	90	3150-4030	3	30-34	Rot.-Cab.
CALIFORNIA								
Kettleman Hills	2	2	3	16	8300-8730	3 or 4	40	Rotary
Wilmington	30	30	19	30	3500-4000	2 and 3	18-20	Rotary

Field Activities by States for May, 1938

State	Completions		Producers		Locations		Rigs		Drilling Wells		Production, 1937 (In Barrels)
	May	April	May	April	May	April	May	April	May	April	
Arkansas	23	23	18	19	14	24	15	20	32	35	12,088,341
California	112	112	105	93	117	109	106	87	228	235	238,587,663
Colorado	....	1	....	1	....	....	2	2	28	27	1,532,893
Illinois	125	89	103	71	....	....	159	161*	57	56	7,376,022
Indiana	12	5	8	2	....	....	2	5	26	26	820,000
Kansas	143	137	101	101	125	159	35	42	229	249	70,542,000
Kentucky	64	48	44	31	....	....	17	10	75	71	5,500,000
Louisiana	72	71	53	51	94	107	54	52	189	183	90,501,068
Michigan	74	31	45	18	94	65	34	29	140	131	16,254,181
Mississippi	....	1	....	0	....	....	2	4	5	7	Gas Prod.
Montana	5	3	4	3	....	....	2	3	53	50	5,775,000
New Mexico	40	52	34	46	....	....	12	10	168	170	38,642,184
New York	....	....	....	....	....	....	....	....	....	....	5,466,200
Ohio	70	65	47	54	....	....	52	49	127	141	3,547,600
Oklahoma	201	173	154	129	207	205	45	50	321	325	225,402,731
Pennsylvania	....	....	....	....	....	....	....	....	....	....	19,154,400
Texas	1228	1093	964	857	1319	1379	439	429	1457	1397	506,891,233
West Virginia	45	45	34	27	....	....	26	24	98	111	3,833,000
Wyoming	10	7	8	6	....	....	8	9	71	70	19,402,121
Total	2234	1956	1722	1509	1970	2048	1010	986	3304	3284	1,271,316,637

*Includes 123 rigs standing and 38 rigs up.

As TRUE as a BIG GUN FORGING

Bridgeport Drill Collars are bored in the same manner that large gun forgings, which are finished to a tolerance of a few thousandths of an inch, are bored.

Straight and true, every one passes the A. P. I. specifications and tests for correct bore-tolerance and straightness:

> A test bar, ten feet long and ⅛ inch smaller than the bore of the Collar, is passed entirely through each collar before it passes final inspection.

We positively guarantee that no Bridgeport Drill Collar will fail because of inaccurate or incorrect bore.

All Bridgeport Drill Collars are made from forged steel rounds—no rolled steel is used; heat-treatment is uniform from end to end.

Normalized and Heat-Treated types—all sizes and all commonly used lengths—carried in stock. Liberal Terms; Competitive Prices.

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Progress of Major Pipe Line Work

THE Magnolia Pipe Line Company has underway a reconditioning program involving 91 miles of its line in Texas. Work began June 1st and it is expected that the project will be finished by September 1st. W. G. "Bill" Hanrahan, Dallas, has the contract for the work.

The program calls for the taking up of 31 miles of 8-in. pipe west of Beaumont. This will be reconditioned and 15 miles relaid east of the Hull Station and four miles west of the Hull Station. West of the Cleveland Station 14½ miles of line will be taken up and 12 miles relaid in the same place. Northwest of Conroe 16 miles will be taken up and 13½ miles relaid, north of the Richards Station 14 miles will be taken up and 11½ miles relaid, and south of the Brown Station 15½ miles will be taken up and 13 miles relaid.

At the present time the crews are working near Sour Lake. The pipe is being transported to a central plant for reconditioning.

●

The Continental Oil Company is laying about 80 miles of gathering lines in the K.M.A. field, Wichita Falls, Texas, it has been announced by J. G. Dyer, vice-president in charge of drilling and production east of the Rocky Mountains. The lines will carry gas to one main and two auxiliary casinghead gasoline plants being erected in the field. Mattison-Wallack and Company, Oklahoma City, Oklahoma, have the contract for laying the lines.

●

The Texas Company has surveyed the right-of-way and formulated plans for a 250-mile, 12-in. pipe line from its Terrebonne Bay group of fields, South Louisiana, to Port Arthur, Texas, where the company has a refinery. Although it has not been definitely decided that the line will be laid, plans are being completed so that its construction can be accomplished at any time officials of the company deem it desirable.

The line would replace the water transportation system now serving these fields. The former would provide a faster and more convenient method of moving the oil. The Texas Company owns the Lake Barre, Caillou Island, Lake Pelto, Dog Lake and Four Isle fields, and has large holdings in the Leeville field, and owns a number of proved salt domes and prospects. All are in the Terrebonne Bay area and are either on the bay or adjacent marsh land. The company also owns or has considerable holdings in numerous other fields that would be served by the line.

Construction of the line will be dependent, in part, upon whether it is considered desirable from an economic viewpoint.

●

Contracts have been let and the right-of-way is being cleared for the laying of a 290-mile, 12-in. pipe line by the South American Gulf Oil Company from the Barco Concession in Columbia to Covenas, on the Caribbean Sea. The South American Gulf is owned jointly by The Texas Company and the Socony Vacuum Oil Corporation, officials of which estimate the line will cost $10,000,000 to $15,000,000. It will require a year and a half to two years to construct.

Lindgren and Swinerton, Inc., San Francisco, California, has been awarded the general contract. The contract for electric welding has been sublet to the Brown Welding Company, San Francisco.

The line will run from the concession west to La Gloria and thence to Covenas. En route to La Gloria it will go through the Bobali Pass, which has an elevation of more than 4000 ft., and is the gateway from interior Colombia to the seacoast. From La Gloria to Covenas, a distance of 140 miles, it will be possible to handle the oil by gravity flow.

C. S. Atwell, New York City, is in general charge of the construction of the line, his headquarters being at Barranquilla, Colombia.

●

The Atlantic Refining Company is increasing the storage capacity of its water terminals at Newark, New Jersey, New Haven, Connecticut, and Kettle Point (Providence), Rhode Island. Docking facilities at Newark also will be enlarged.

Two new all-welded steel storage tanks having a capacity of 1,120,000 gal. each will be erected at Newark. One new tank having a capacity of 750,000 gallons will be erected at New Haven, and one new tank having a capacity of 725,000 gal. at Kettle Point. The contract for the tanks has been awarded to the Chicago Bridge and Iron Company. Total cost of the increased storage and docking facilities will be about $270,000.

●

Construction of a new pier to serve the Bay of San Diego will be started June 15 by Shell Oil Company, according to announcement from company headquarters. The new pier will be situated at the foot of Crosby Street on the same site as the present pier, but will be much larger and will embody all the latest equipment and conveniences for marine business. The new structure will have a two-lane approach 16 ft. in width, extending 200 ft. from shore to the service portion of the pier, which will be another 100 ft. long and 24 ft. wide. Completion of the pier is planned for July 25.

●

The Phillips Petroleum Company has let a contract for the laying of a 35-mile gas line from Crane to Judkins, Texas. Officials of the company also state an oil line will be constructed from the Goldsmith field to its new refinery at Judkins.

●

The Fisher County Pipe Line Company has been formed with C. W. Edwards, Rotan, Texas, as president, Letcher D. King, Abilene, vice-president, and William H. Waldrop, Abilene, secretary-treasurer, to lay a 12-mile 2-in. pipe line from the Rotan field. It will have a daily capacity of 1400 barrels. The company has contracted to double the line's capacity within 90 days or construct a 4-in. outlet. The line will connect with the Humble Pipe Line Company's trunk line from the Royston field.

●

The Derby Oil Company, Wichita, Kansas, has announced it will extend its pipe line system south from the Robbins pool, Sedgwick County, to the Wellington pool, Sumner County, a distance of 20 miles. The line will be constructed of 4-in. pipe.

●

The Arkansas-Louisiana Gas Company, Shreveport, Louisiana, is surveying the right-of-way for a 6-in. gas pipe line to extend from the Schuler field, Union County, Arkansas, to El Dorado, a distance of 18 miles. Gas will be supplied to the field for drilling, repressuring, and general lease operation.

THE LIGHT THAT NEVER FAILS

See those lighted bulbs? This series of bulbs is one of your many assurances that when you buy Youngstown tubular goods you buy assurance that every joint will be uniformly good. *Every single joint* of Youngstown tubular goods is hydrostatically tested. When correct pressure is reached (and only then) the first bulb lights; when that pressure has been maintained for the right length of time, the second light flashes.

This is only one of many tests which Youngstown tubular goods must pass before it can be shipped. With pipe as uniform as Youngstown, you save time and trouble, you get a better job.

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YOUNGSTOWN

STEEL TRADE MARK YOUNGSTOWN PIPE

The Month's Activities in Refining

Percent Refining Capacity Operated

Western Division, 66.2 Percent **Central Division, 74.7 Percent** **Eastern Division, 75.0 Percent**

THE Mohawk Petroleum Corporation, San Francisco, California, has signed a license agreement with Universal Oil Products Company, Chicago, to cover existing cracking operations in its refinery at Mopeco, near Bakersfield, California.

Alfred Marsten is president and Frank Long vice-president of the Mohawk Petroleum Corporation, which recently purchased the Mohawk Petroleum Company.

Mohawk is the second independent California refiner to sign a Universal license agreement for the use of the Dubbs cracking patents, the first being the Wilshire Oil Company, Inc., Los Angeles, which in 1936 installed an 8000-bbl. per stream day two-coil selective type Dubbs cracking unit, a 2,500,000-cu. ft. per day U. O. P. polymerization plant a year later, and now has under construction a 4000-bbl. per stream day Dubbs reforming unit.

●

Koppers Company's Western Gas Division, Fort Wayne, Indiana, has been awarded two construction contracts by the Sinclair Refining Company, New York, New York, for the latter's East Chicago, Indiana, refinery. The contracts are for a riveted and weld-caulked water-sealed gas holder having a capacity of 750,000 cu. ft., a sweating tank 25 ft. in diameter and 18 ft. high, three open-top rundown tanks, 26 ft. by 10 ft. by 8 ft., and two hot water tanks 12 ft. high and 8 ft. 6 in. square. The tanks are to be of all-welded steel. The gas holder will be completed in October and the tanks in August.

●

Hydro-Pete Oils, Ltd., Calgary, Alberta, Canada, is considering the construction of a refinery either at Vegreville or Camrose, Alberta, P. L. Hyde, president of the company, states. The company recently placed in operation a small refinery at Red Deer.

●

The British American Oil Company is considering the erection of a 5000-bbl. refinery in southern Alberta, Canada, it has been announced, and sites are being investigated in East Calgary and at High River and Okotoks. The company already has refineries at a number of points in Canada.

The Hamman Exploration Company, Houston, Texas, will erect a natural gasoline plant of the absorption type in the South Bay City field, Matagorda County, Texas, it is announced. The capacity of the plant will be between 40,000,000 and 50,000,000 cu. ft. of gas per day. The Western Supply Company, Tulsa, Oklahoma, has been awarded the contract for the construction of the plant.

●

The new cracking unit being installed by the Rodessa Oil and Refining Company at its Shreveport, Louisiana, plant, will be placed in operation the latter part of this month, it has been announced. The new unit will make possible the manufacture of a high-octane gasoline.

●

Continental Oil Company has under construction one main and two auxiliary casinghead gasoline plants in the K. M. A. field, Wichita Falls, Texas, J. G. Dyer, vice-president in charge of drilling and production east of the Rocky mountains, announces.

The main, compression-type plant is being erected on Continental's Waggoner lease, near Wichita Falls. Five 400-hp. Clark angle-type compressors are being used. The initial installation, having a capacity of 15,000,000 cu. ft. of gas daily, will provide for return of gas to the various leases at pressures sufficient to permit repressuring, a conservation measure for increasing the recovery from the leases served.

The contract for constructing the plants has been let to The L. S. Gregory Engineering Company, Tulsa, Oklahoma.

●

United British Oilfields of Trinidad is planning an expansion and modernization program for its refinery at Port Fortin involving the expenditure of about $1,700,000.

●

The Producers Refining Company, Shelby, Montana, has asked for construction bids on a 3000-bbl. refinery to be erected in northern Montana. A Dubbs cracking unit of about 1500-bbl. capacity will be a part of the equipment installed. James W. Johnson is the head of the Producers Refining Company and has made no definite announcement of the location of the plant. It is expected to be either at Shelby or Cut Bank, however.

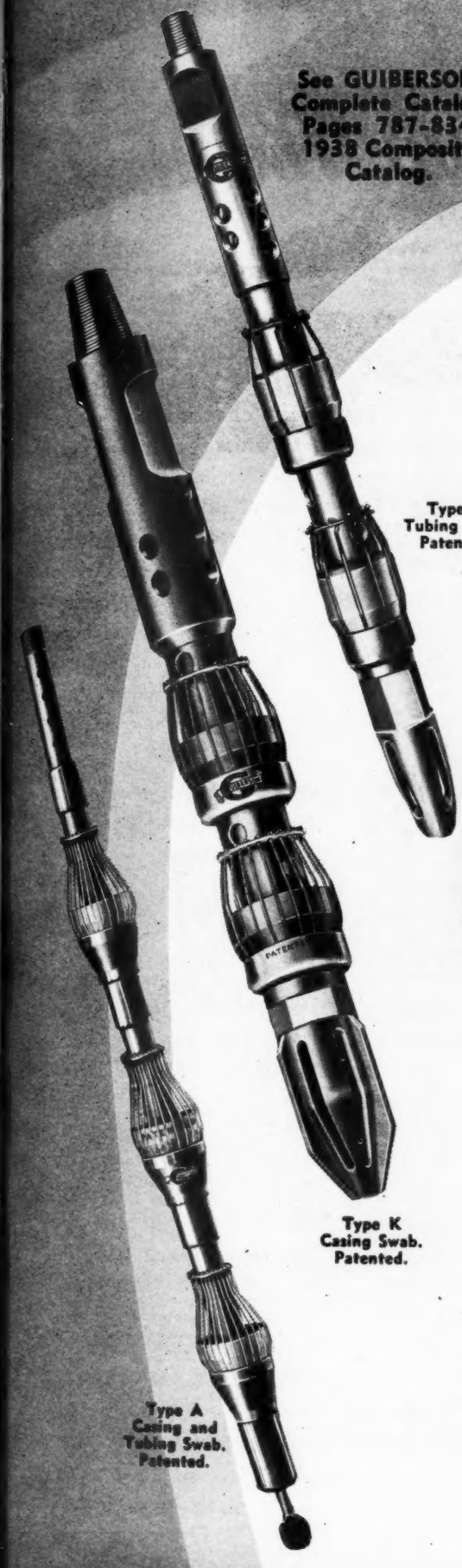
Crude Runs to Stills, Gasoline and Gas and Fuel Oil Stocks
Week Ended June 4, 1938

A.P.I. Figures
(Figures in Barrels of 42 Gal. Each)

DISTRICT	Percent Potential Capacity Reporting	Daily Avg. Crude Runs to Stills	Percent Operated of Total Capacity Reporting	Total Motor Fuel Stocks Thousands of Bbl.	Gas and Fuel Oil Stocks Thousands of Bbl.
East Coast	100.0	519,000	77.6	23,485	11,233
Appalachian	88.4	89,000	69.0	3,362	1,378
Ind., Ill., Ky.	92.4	384,000	78.5	14,096	8,249
Okla., Kans., Mo.	84.7	282,000	73.6	7,755	4,042
Inland Texas	56.6	125,000	62.2	2,556	1,662
Texas Gulf	95.7	764,000	95.9	11,841	10,229
La. Gulf	96.6	131,000	78.0	2,706	3,407
No. La. & Ark.	63.7	37,000	63.8	490	784
Rocky Mt.	69.7	44,000	71.0	2,199	867
California	90.9	459,000	61.5	14,657	90,041
Reported	89.0	2,834,000	76.6	83,147	131,892
Estimated Unreported		271,000		4,620	2,740
*EST'D TOTAL U.S. June 4, '38		3,105,000		87,767	134,632
*EST'D TOTAL U.S. May 28, '38		3,150,000		87,964	134,315
U. S. B. of M. *June 4, 1937		**3,311,000		79,201	98,179

*Estimated Bureau of Mines' Basis.
**June, 1937, daily average.

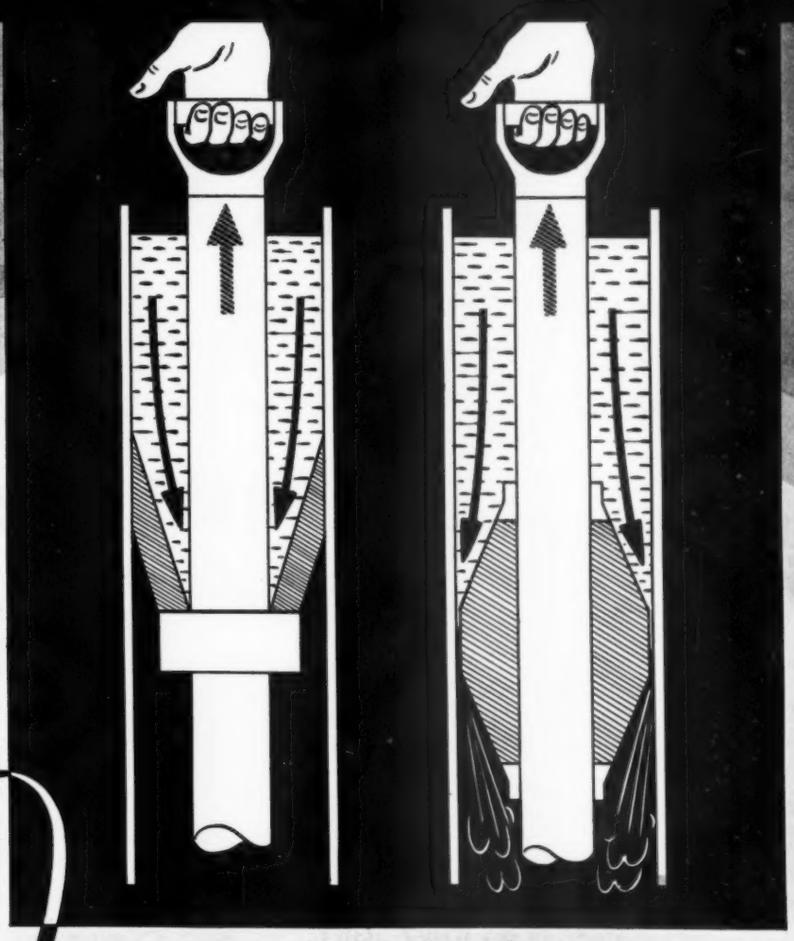
See GUIBERSON Complete Catalog Pages 787-834 1938 Composite Catalog.



Type K Tubing Swab. Patented.

Type K Casing Swab. Patented.

Type A Casing and Tubing Swab. Patented.



WHICH IS the CORRECT swabbing principle?

• The answer is obvious! The GUIBERSON Swab cup concentrates all the fluid pressure inside the cup, insuring tight contact between rubbers and casing with NO LEAKAGE. Solid type swab cups concentrate fluid pressure between rubbers and casing—insuring LEAKAGE!

That is the reason why the patented GUIBERSON Swab —the only correct-principle swab—revolutionized swabbing and has done most of the world's swabbing ever since it was introduced. Over ninety per cent of the swabbing done today is done by GUIBERSON Swabs. The GUIBERSON Swab, because of its correct principle with its flexible cups, raises a full load—runs in faster—runs in and out without sticking—and same cup will fit varying diameters of pipe.

Special steel-reinforced, composition cups protected by steel wires have maximum life. Cups are easily removed and renewed by simply unscrewing bottom connection.

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Box 1106, Dallas, Texas
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BETTER BE SAFE THAN SORRY

GUIBERSON

A Great Show May Be

A GREAT MANY superlatives are required to describe the International Petroleum Exposition held in Tulsa, May 14 to 21. The all-time attendance record was broken when upwards of a quarter of a million visitors filed through the gates during the eight-day period. The previous record, established in 1936, had been well under two hundred thousand. Some fifty percent more exhibit space was sold than ever before. Estimates set the total value of the equipment exhibited at $15,000,000.00. Every item of oil industry equipment from set screws to rotary drilling rigs worth $200,000.00 was on display. An automatically-operated pipe line station was to be seen in operation and an actual oil well that made a showing of gas was drilled.

Another record fell when a survey showed that actual sales estimated between $4,000,000.00 and $5,000,000.00 were recorded. Inestimable are the sales that will result later from contacts made at the show. Not only the main show buildings but all supply company and specialty company buildings on the grounds were of modernistic design with lighting effects which, at night, gave the setup every right to the title "The World's Fair of the Oil Industry." The lack of adequate restaurant facilities so evident in the past was supplied with the new well-appointed and efficiently-conducted Cafe de Petrol.

One of the most discussed and genuinely appreciated features of the show was the registration conducted by *The Petroleum Engineer* from a building erected especially for the purpose on Drake Drive. This provided for the "badging" of each visitor connected with the petroleum industry. The badge contained the individual's name and company affiliation. This service supplied a much-needed element to the success of the show and was made possible by the coöperation of some ninety-four manufacturers who participated with *The Petroleum Engineer* in effecting the plan. Without exception, the companies coöperating expressed high praise for the efficient manner in which the registration was conducted. Because of the preëminent success of this year's registration, *The Petroleum Engineer* will, in conjunction with the oil industry manufacturers who wish to benefit, repeat the registration at the 1940 show. The general plan of the 1938 registration will be followed, except for a few changes which experience indicated would enhance further the value of the plan.

Will Publish Show Newspaper

In addition *The Petroleum Engineer* will supply an adjunct which the magnitude of the Tulsa show urgently calls for—a daily newspaper. This will be called *"Oil Show Daily"* and a sufficiently large editorial, reportorial, and photographic staff will be maintained to chronicle daily the outstanding happenings of the show and make possible the reproduction not only of staff photographs but those taken by the scores of amateur candid camera men who are constantly to be seen in action on the grounds. The publication will carry the daily program of events, a directory of exhibits, as well as full accounts of all speeches, safety activities, names and photographs of celebrities in attendance,, etc. We believe this announcement will be well received since a daily newspaper will give both the show visitors and the exhibitors an even better appreciation of events and, by directing attention to special features will enable each visitor to eliminate much lost motion in his attempt to gain maximum benefit from the show.

Though the highly satisfactory manner in which the show was conducted leaves little in the way of improvement to be desired, a few pertinent suggestions were offered at a meeting of Oil Show officials and directors with many of the exhibitors. These will be given consideration in connection

Be Made Even Greater . . .

with the 1940 show and include ideas for improvement in the housing situation, the advisability of exhibitors eliminating outside entertainment from their booths, the thought that exhibits might be better arranged as to their classification in the industry, etc.

Foreign Exhibits Building Needed

To these suggestions might be added a feature that we have long advocated — the erection of a building for exhibits of foreign governments. In this might be included space for exhibits of the various states of the U.S.A. that produce petroleum in commercial quantities. Exhibit space in this building should be donated by the International Petroleum Exposition and arrangements made for the admission duty free to this country of exhibited products. A foreign exhibits building would mean that, in 1940, the attendance not only would be international but the show would also enjoy an international rating with respect to exhibits. If this plan appears feasible, a committee should be appointed at once to consider it.

It is, of course, imperative that the housing situation be improved and, in this connection, we offer the following suggestion. While the throng in attendance was efficiently handled by the housing committee throughout the week, facilities would have been woefully inadequate had they been five times as large, to take care of the many who desired hotel accommodations rather than apartments and private homes.

Might not this situation be greatly improved, perhaps actually rectified, if the show could be conducted for a period of two weeks rather than one? In such an event, the oil companies could send their men to Tulsa in shifts, each group, for instance, spending two days, then returning so that others might attend. Under the present arrangement the larger supply companies and specialty manufacturers remove their best men from their regular territories so that they might be in Tulsa for the entire week. The men are actually off the job for ten days or two weeks when traveling time is considered. This temporarily disrupts each company's sales program and the break might be prevented insofar as the central producing area is concerned if the show were continued over a two weeks' period. That is to say, the central area could be divided into five divisions, namely, Southern Illinois and Kansas; Oklahoma and North Texas; East Texas, North Louisiana and Southern Arkansas; West Texas and New Mexico; and the Gulf Coast regions of Texas and Louisiana. Special periods of, say, two days, could then be devoted to each of these divisions. The equipment salesmen from each area could be brought to Tulsa for the period set aside for their territory and then returned to make way for the next group. Such a plan would not only aid in handling the housing situation but would increase total attendance at the show if the industry were made aware that adequate housing facilities had been provided. It would also remove the objection of the economic unsoundness of the present plan of conducting the show for only one week, when the formidable cost of the average exhibit distinctly calls for its longer continuation.

These suggestions are offered with the hope that they will be given the consideration they merit and we believe that, if adopted, they will remove the few remaining objectionable features to what is already the World's Greatest Industrial Show.

L. Morris

President.

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THE Petroleum Engineer

JUNE, 1938

Coating and Wrapping Line Pipe at Centralized Plants

A uniform coating, less waste of material, and elimination of weather as a factor, are some of the advantages over application by workmen on the job

By FRANK H. LOVE

THE coating and wrapping of line pipe at centralized plants using stationary equipment has certain recognized advantages over application by workmen on the job. Shortcomings of the latter result from unfavorable conditions and inadequate facilities, circumstances that are natural but unavoidable. The introduction of the "holiday detector" revealed the extent to which the practice of field application failed to give maximum pipe protection, something already known in a general way. In addition to the large number of "holidays" found to exist after the pipe was coated, and other objectionable features were the fact that coatings could not be applied during inclement weather, at times causing a serious delay in the laying of a pipe line; and an excessive waste of coating material. These resulted in a search for some method to obviate them. Centralized plants, introduced several years ago and steadily gaining in favor since, seemingly have been the answer. Their use eliminates weather as a factor, as coatings and wrappings can be applied under cover, and because the procedure is systematic and can be performed with adequate equipment, "holidays" and waste of material are eliminated.

An example of the efficiency with which this type of work can be performed using stationary equipment in a central plant is afforded by the procedure of Mayes Brothers, Inc., who operate extensively in the Mid-Continent and Gulf Coast areas. Whenever operations are near enough to the company's headquarters plant at Houston, Texas, to justify it, the pipe is coated at that point, otherwise portable plants are established at points convenient to the pipe line right-of-way. The coating and wrapping procedure is identical.

Pipe is received at the plant in gondola cars and is unloaded by a gin truck onto racks. One section of the plant is equipped for the coating of pipe of ½-in. to 4-in. diameter, and another for pipe of 4-in. to 16-in. diameter. When received the pipe is bare, having acquired a film of rust while enroute from the tube mill to destination. W-G-M mill-type cleaning machines are used to remove this rust and mill scale. These cleaning machines are equipped with the conventional cutters and wire brushes. Attached to the front of the machine is a priming head. After the pipe is cleaned and primed it is placed on the prime rack to dry, which usually requires one to two hours, depending upon weather conditions. The primer

A plant for the coating and wrapping of pipe established conveniently to the right-of-way of the pipe line

is allowed to dry thoroughly before the pipe is run through the coating and wrapping machines, so that the bond between the coating and primed pipe will be perfect.

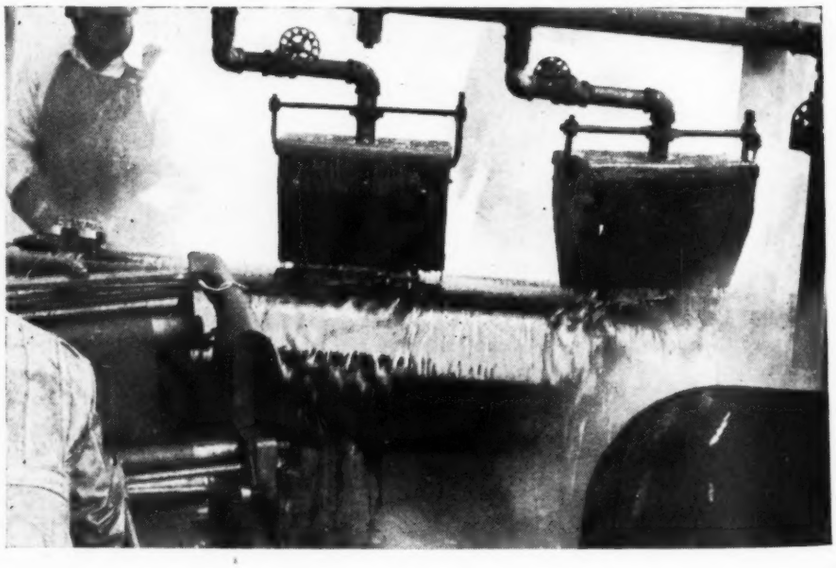
Coating and wrapping is a continuous operation. The pipe is placed on back-table rubber rollers, which can be adjusted to fit the size of the pipe. The rollers are arranged to give a specified lead. Various widths of wrapper are used for various diameters of pipe, i.e., 6-in. wrapper on 4-in. pipe, 9-in. wrapper on 8-in. pipe. The pipe moves spirally at uniform speed, each revolution of the pipe carrying it forward the prescribed distance to fit the felt being used. A special coupling makes it possible for one joint of pipe to be fastened to another while in motion, eliminating the loss of time incident to stopping the machinery while a connection is being made. Increased production is thus possible as well as more nearly uniform coating and wrapping.

As the pipe passes over the working pot the hot coating is flowed over it from hoppers. The number of hoppers is varied according to the number of coats desired. Usually two coats are applied. As the pipe moves spirally the coating is applied smoothly and the thickness is uniform. Surplus coating material that does not adhere to the pipe falls into the working pot beneath. It is picked up by a small centrifugal pump that boosts it to the header, where it enters the hoppers again. Meanwhile fresh bitumen is being added in a molten state from the auxiliary melting pots. Beneath the working pot are two horizontal-type gas burners that maintain the proper temperature of the coating material.

The felt and the paper reels are so placed that these wrappers can be applied immediately after the hot coating is "flooded" onto the pipe. Both reels are set at an angle determined by the lead on the pipe to obtain the desired lap of ¾ in. to 1 inch. After the coats of bitumen are applied, the felt and kraft paper follow while the bitumen is still molten. This permits all materials to bond together and make a neat and homogeneous mass. As the pipe leaves the paper reel the end is placed on a buggy that runs along a track resembling a miniature railroad track. A "breakout" buggy catches the other end of the joint and uncouples it, and it is then rolled onto the finish rack. An appropriate distance is left uncoated on each end of each joint so that it can be joined in the field without injury to the coating and wrapping. The finish racks, on which the pipe is placed before being loaded onto trucks for transportation to the job, are well padded to avoid damage to coatings and wrappers.

The hot bitumen is applied to line pipe in a thickness of about 3/32 inch. The temperature usually is specified by the manufacturer of the coating material being used; however, it usually is 400 to 475 deg. fahrenheit.

When a central plant is established in the field the site is, of course, selected with a view to its convenience to the construction work. As the construction crews move forward the site of the plant must be changed to keep pace. For 6-in. pipe or larger the plant usually must be dismantled and rebuilt after about ten miles of line has been laid. This is no hard and fast policy and local conditions are influencing factors. Approximately three days are required to dismantle and reassemble a field plant; however, as the speed of coating and wrapping is sufficient to keep well ahead of the construction crews, this loss of time is not a factor to be considered.



Hot enamel is flooded onto the pipe from hoppers, the number of hoppers depending upon the number of coatings desired

The Turbo Drill—A Development That May Lead to Changes in Present Rotary Drilling Practice

Now in operation in California, the turbo drill, which is a turbine-driven bit operated by the mud fluid, makes higher bit speeds feasible and reduces torsional stress in drill pipe because of the drill stem being stationary while drilling

By WALLACE A. SAWDON
Petroleum Engineer, Los Angeles

C. C. SCHARPENBERG

A DEFINITE change in technique for drilling deep wells where drill pipe torque is an important factor may result from the completion of one well and the present drilling of another using a new turbo drill. In this drill, power for bit rotation is developed at the bottom of the hole and the long string of drill pipe is not rotated to turn the bit but serves merely to carry the bit, to provide weight control, and to transmit the fluid from the surface of the ground to the turbine to which the bit is attached.

This drilling unit is the Scharpenberg Turbo Drill and was invented a number of years ago by C. C. Scharpenberg, chief production engineer for Standard Oil Company of California.

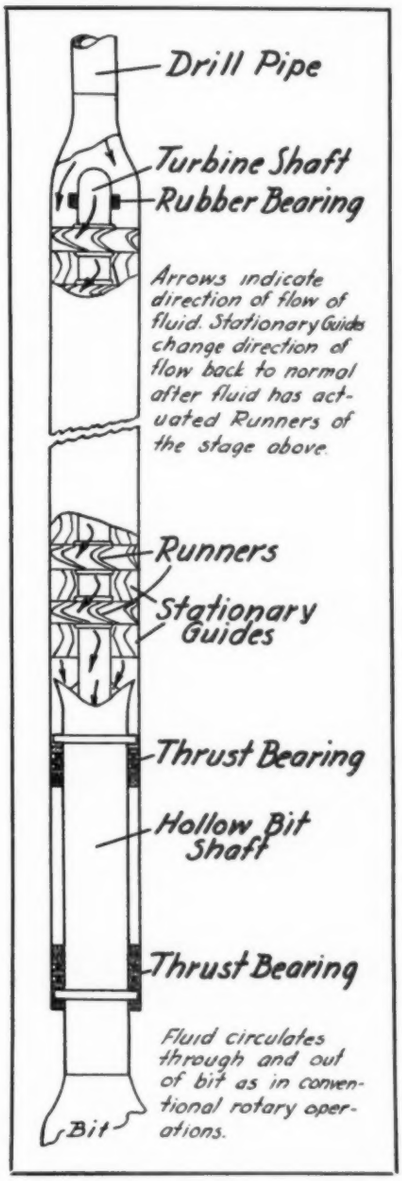
It has been recently improved and developed by the A. O. Smith Corporation of Milwaukee, in conjunction with the Standard Oil Company of California, and the results obtained prove the adaptability of the submerged turbine assembly for deep-well drilling.

As early as 1883, George Westinghouse obtained a patent on turbine-powered well-drilling equipment although he knew nothing about oil-well drilling, and rotary drilling equipment had not yet been developed. The Capelushnikov turbine drill has been used in Russia for ten or twelve years but this equipment has a speed reduction device and has been used only in comparatively shallow wells. Other types of hydraulic-powered drills are in various stages of development but the actual results obtained using the Scharpenberg Turbo Drill provide definite data on the adaptability of the equipment for high-speed rotation.

The completed well in the West Coyote field was drilled, and the present drilling well, No. 15-2 on the Canfield Ranch just east of the Ten Section field, is being drilled by the A. O. Smith Corporation, which has been cooperating with the Standard Oil Company of California in the development of the turbo drill. The first well was drilled and completed below 4000 ft. in less than a month, 18-in. hole being carried to a depth of 3150 ft. and 12½-in. hole to 3900 feet. At the present time the well in the San Joaquin Valley is drilling below 4000 ft. and is being drilled with a 9-in. O. D. turbo drill.

The general construction of this turbo drill is indicated by the accompanying sketch. The 9-in. O. D. size shown in the illustrations is 27 ft. in length and, as can be seen, resembles a drill collar in appearance. It consists of 20 stages and each stage is rated at 3 hp. with a 9-lb. pressure drop. The turbine design is the Jonval axial flow type. The turbine shaft is approximately one-half the diameter of the hollow bit shaft, which is equipped with two thrust bearings that have reversible duplex races. The turbine unit is mud-lubricated throughout, no oil or grease being used in the whole assembly.

The Jonval axial flow type turbine is a reaction turbine in which fluid is under pressure at the runner, the energy being derived by diverting the path of the fluid in passing through the runner. The fluid enters the tur-


Drill Pipe
Turbine Shaft
Rubber Bearing
Arrows indicate direction of flow of fluid. Stationary Guides change direction of flow back to normal after fluid has actuated Runners of the stage above.
Runners
Stationary Guides
Thrust Bearing
Hollow Bit Shaft
Thrust Bearing
Fluid circulates through and out of bit as in conventional rotary operations.
Bit

General construction of the turbo drill is shown in this sketch

bine between fixed guide blades, passing spirally through the passages and discharging in a direction parallel to the turbine shaft.

The runners (impellers) have the angle of the blades selected to give the desired speed. The stationary guides direct the flow to the normal direction after the fluid has actuated the runners of each stage. The 9-in. turbine is designed for a speed of 600 r.p.m. but a speed of 1200 r.p.m. has been used with a 5-in. turbine driving an 8-in. bit. The peripheral speed of the bit is the governing factor and at the present time this speed is not allowed to exceed 3000 ft. per minute.

When an 18-in. bit is turning at 600 r.p.m. the peripheral speed is 2830 ft. per min. and this seems to be about the fastest desirable with the bit designs now available. Bits of various types and makes have been used in the well now drilling. The weight carried on the bit being rotated at 600 r.p.m. has ranged from 1½ to 4 points, according to the formation being drilled. Hole-making speed naturally varies with the formation being penetrated but the advantage of the high speed obtainable with the turbo drill is obvious.

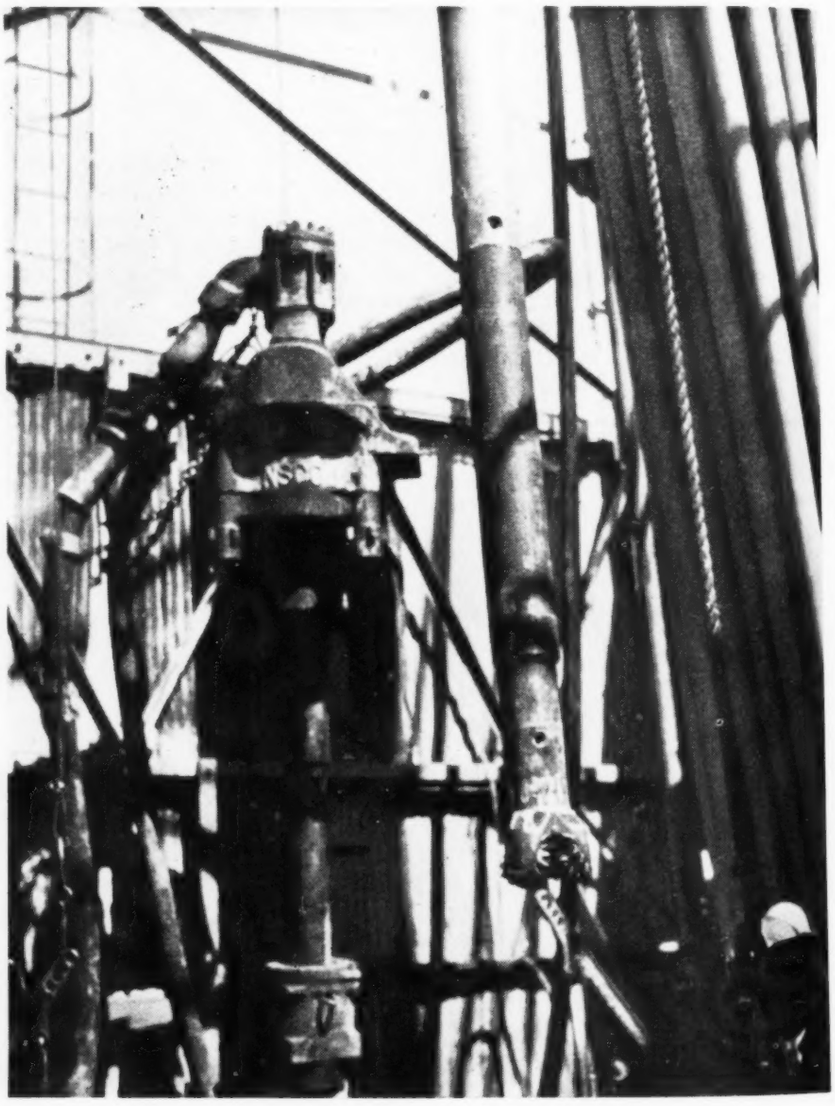
Conventional rotary drilling equipment is being used throughout on the present drilling operation. The drill pipe is 5-in. full hole and the kelly has a 3-in. bore. The swivel is the two-hose type and 2½-in. hose is used. Mud fluid is provided by two 16¼-in. by 7¾-in. by 20-in. pumps at a rate of 700 to 800 gal. per minute. On the first well the fluid pressure never exceeded 515 lb. per sq. in. and to the present time the pressure used in the well now drilling has not exceeded 650 lb. per sq. inch. The fluid velocity has not been allowed to exceed 20 ft. per second at any place in the system.

The heaviest mud used has been 80 lb. per cu. foot. That used in the first well averaged 78 lb. in weight and 40 seconds viscosity. In the well now drilling the mud ranges from 72 to 74 lb. per cu. ft. and has a viscosity of 24 seconds. The mud is kept in condition at all times and the returns pass over two vibrating screens.

The turbo rotating unit at the bottom of the hole is constructed with a pawl and at times during drilling the rotary table will have a backward drift. This indicates resistance to cutting by the bit and helps to indicate performance. The action of the rotary table, therefore, can be used in conjunction with the weight indicator to obtain effective drilling control. When the bit "hangs-up" the table spins backward.

While running in the hole or at any other time when it may be desirable, the bit can be turned by rotating the table as in ordinary rotary drilling operations, as the bit will rotate only forward. There is no danger of unscrewing as the rotation of the pipe in reverse direction originates at the bottom and tends to tighten the joints in the same manner as normal rotation from the top.

Use of the turbo drill does not eliminate any of the equipment used in conventional drilling operations but it does offer advantages that are clearly evident. It prolongs the life of the drill pipe and eliminates the hazard of twist-offs. Higher and higher rotating speed has been an obvious objective of many operators during the last year and the turbo drill can certainly provide the highest speed desired or that can be used with present bit design. How much rotating speed will be increased cannot be foretold but improvement in bit design to permit faster rotation may introduce speeds that are perhaps hard to conceive at the present time.



A rock bit made-up on the turbo drill ready to run in the well now drilling near Ten Section field, California

View of the new high-pressure cementing pump

High-Pressure Pump Designed for Cementing Operations

Its strength, power, and portability make it adaptable to any high-pressure service

By WILLIAM D. OWSLEY

UNPRECEDENTED increases in operating pressures during the last three years resulting from the development of deeper fields having correspondingly higher pressures, also a steady trend in the industry toward use of power other than steam, have caused an insistent demand for power-driven pumping equipment adapted to oil-well cementing, high-pressure circulating, well-killing, and portable rotary-drilling operations. Pressures required greatly exceed the capabilities of any portable pump previously used. New types of cementing operations such as the squeeze job, with their attendant high pressures and use where steam is not available, have had a major share in the development of entirely new specialized pumping machinery.

Realizing the great need for readily portable, heavy-duty, high-pressure pumps, the Halliburton Oil Well Cementing Company set to work to design and develop such equipment. After some 14 months of preliminary design and experimentation the finally accepted and proven design has been placed on a high production schedule in order to meet the demand in high-pressure areas as quickly as possible.

The new pump is duplex, double acting, and has a 10-in. stroke. The maximum piston size is five in., but for general use the pump is equipped with 4½-in. pistons. As designed, the pump has a working pressure of 4500 lb. per sq. in. when equipped with 5-in. pistons and 6000 lb. with 4½-in. pistons. When truck-mounted and driven by a 110-hp. gasoline engine through transmission and power-take-off the volumetric capacity ranges from 360 bbl. per hour at 100 r.p.m. to 44 bbl. per hour at 6000 lb., using 4½-in. pistons. The weight of the pump ready for installation is 4350 lb., which includes valves, pistons, rods, and crankcase oil.

In appearance and the general arrangement of its parts, the pump is a departure from formerly accepted ideas for this type of machine. It is of vertical construction, resembling marine practice, the fluid end being placed above the power end, which was designed to mount within a space of 30 to 37 inches. Such arrangement permits mounting the pump between the side channels of a truck chassis, resulting in several distinct advantages, such as: low center of gravity, localizing of weight between sides of chassis, reduction of required mounting space on truck bed, and greater accessibility of power-take-off shaft. Setting the pump with the line of the crankshaft across the truck chassis places the inertia loads of the heavy rotating parts vertical to the springs, resulting in almost vibrationless operation, an important feature when fluid is being measured from the truck tank. Another advantage that resulted was

the elimination of all but one exposed shaft, this being the shaft from power-take-off to pump crankcase.

The power end is a completely enclosed unit in which the crankshaft, carrying in its center the ring gear for the double-enveloping worm gear drive, is mounted on spherical roller bearings, the worm being slung below the crank in an oil bath. Thrust from the worm is taken on angular-contact ball bearings and the opposite end is supported on straight roller bearings floated to allow for expansion. The crankshaft was made hollow to reduce weight as well as to enable thorough heat-treating of the metal section. The connecting rods utilize steel-backed cadmium-nickel bearings on the crank throws and Oilite bronze bushings on the pin end at the crosshead. The crossheads are equipped with bronze shoes running on split cylindrical crosshead guides and are made fully adjustable for wear.

As the fluid end was intended principally to handle heavy, viscous fluids under high pressure, every effort was made to eliminate the difficulties that have been encountered with other pumps when subjected to this type of service. With these things in mind the designers made fluid passages large and reduced the number of bends to a minimum. Large valve area was provided throughout the pump, the suction connections being directly beneath the valve seats. The fluid end is made in two sections held together by six large tie rods, thus exposing the liner walls except where connection is made at each end. Liners are threaded into the lower half of the fluid end, seating there on a beveled surface sealed with a lead ring. The upper end of the liner floats in the top half of the fluid end, being sealed-off there with a V-type packing gland. As the liner walls are exposed, there is no possibility for cement to accumulate around them and harden in place, rendering removal from the pump difficult; rather they may be installed or removed by use of chain tongs after the cylinder heads are removed. Individual valve pots are provided, and their covers are secured by four studs each.

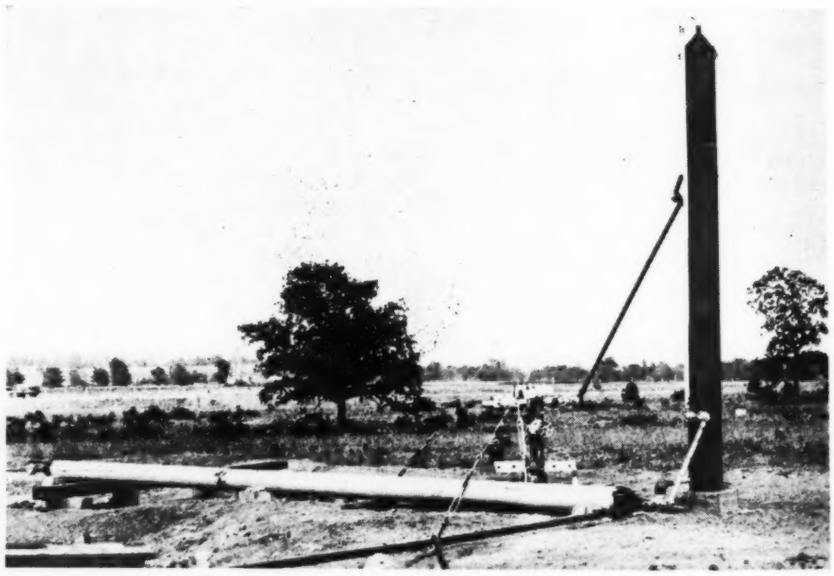
Cast alloy steel of the chrome-nickel-molybdenum type is used throughout the pump. All parts including the crankshaft and connecting rods are cast and heat-treated. The highly stressed working parts receive heat treatment that results in a yield point of 118,000 lb. per sq. in. and other parts, such as the base sections and fluid ends, are normalized and drawn to give 80,000-lb. per sq. in. yield point. All studs and bolting are made of heat-treated SAE 4140 steel having 109,000-lb. per sq. in. yield point.

Use of a double-enveloping worm gear of the cone type in a ratio of 18½ to one permitted elimination of a jackshaft, and at the same time produced a very strong assembly by virtue of surface contact across four teeth constantly in mesh. The worm is made of heat-treated hardened steel and the gear is a special extra-strong gear bronze. Gears of this type will transmit loads of large hp. and torque and may be mounted in much smaller housings than single-enveloping worms or herringbone gears.

Although the design and qualifications of this pump are not such as to render it applicable for general pumping operations, they are highly desirable in pumps used for specialized service such as oil-well cementing and portable rotary drilling.

Removing Excessive Moisture and Production Water From Gas

ON one of its leases in Okfuskee County, Oklahoma, Ohio Oil Company uses two simple devices to remove excessive moisture from the gas before it enters the pipe line. One branch of the modified Christmas tree used on the string of tubing in the well is connected by 2-in. pipe to a vertical separating column. This column is made of 20-in. pipe, and a single baffle is inserted at about two-thirds its height, below which the gas enters. Water separated from the flowing gas falls to the base and flows through a second 2-in. line to a horizontal reservoir near the column. This reservoir is blown by the line walker as frequently as necessary. Gas free of water leaves the top of the column through a riser that connects to the flow line just before the gas is heated for transportation. To prevent distortion of the piping by contraction and expansion or change in the setting of the column, double swings are placed in the piping between the well and the column and between the column and the flow line.



Ohio Oil Company's No. 2 Mary E. Clark, Okfuskee County, Oklahoma. Arrangement shows how water is removed from the gas

An evaporation pit near the blow-down outlet of the reservoir prevents spreading of the salt water to adjacent farm lands.

Method for Calculating Oil Evaporation Losses

Gauging the oil at beginning and end of test, using change in specific gravity as index of evaporation, and correlating the change in vapor pressure of liquid with evaporation loss are the methods commonly employed—the last is here discussed in detail

PART 1

By WALTER F. ROGERS

Houston Chemical Laboratory,
Gulf Oil Corporation, Gulf Production Division

It is generally known that the evaporation loss of crude oil from storage tanks can be determined in several ways. The first and most common method is that of gauging the oil at the beginning and end of the test. A second method is to use the change in the specific gravity of the oil as the index of evaporation. A third way is to determine the change in the vapor pressure of the liquid and correlate this measurement with the evaporation loss.

Determining the evaporation loss by gauging is applicable only to oil in storage. This method would seem to be simple yet accurate, as it seemingly requires a minimum of data, all easily obtained. These data are: the gauge of the oil at the beginning and the end of the test, the corresponding oil temperatures, the specific gravity of the oil, and the tank table. These data, however, are not always so easy to obtain correctly. It is a relatively simple matter to gauge the oil volume of an 80,000-bbl. tank to ⅛ in. or 20 barrels. It is also easy to measure the specific gravity of the oil. On the other hand, the average temperature of the oil body is not so easy to measure. In addition, the tank may leak sufficiently for the unknown leakage loss to be as great as or greater than the evaporation loss. These difficulties frequently lead to erroneous results. To show the difficulties of this type of measurement, typical losses of crudes as measured by the method of gauging are given in Table 1. These are from two tests run in aluminum-painted 80,000-bbl. tanks at locations 500 miles apart. The oils were entirely different and the gauging and temperature measurements were made by different though competent gaugers. The data show that the losses were so erratic that little dependence can be placed on the final values.

The method of determining the evaporation loss of an oil by following the change in the specific gravity has advantages over the gauging method. It can be used either for oil in storage or in transit, the only requirement being that no contamination with other liquids occur. Losses of oil from the tank or line do not affect the measurement, nor is it necessary to measure the average temperature of the mass of the oil. It is necessary to obtain a true sample of the oil at the beginning and completion of the test. From the original sample, data are obtained showing the change in specific gravity with evaporation loss. The specific gravity of the final sample is then compared with the standard gravity-loss curve to determine the oil loss.

The method using the change in the vapor pressure of the liquid has been shown by Chenicek[1] and Whitman to be excellent for gasoline. The vapor pressure of gasoline when plotted on semi-log paper against the percent distilled is a straight line. For crude oils the similar vapor-pressure curve is not a straight line because of the great difference in the vapor pressures of the

[1]G. W. Chenicek and W. G. Whitman, Determination of Evaporation Loss. P. 78, *Oil and Gas Journal*, November 13, 1930.

TABLE 1
Oil Evaporation Loss by Gauging Method

TANK A 80,000-Bbl. Tank Painted Aluminum		TANK B 80,000-Bbl. Tank Painted Aluminum	
Storage (Days)	Gauged Loss (Bbl.)	Storage (Days)	Gauged Loss (Bbl.)
55	10	101	240
83	22 gain	139	377
111	120	176	497
139	203	234	460
168	62	271	437
197	9	289	314
225	38		
253	91		
282	31		
310	38		
338	4 gain		

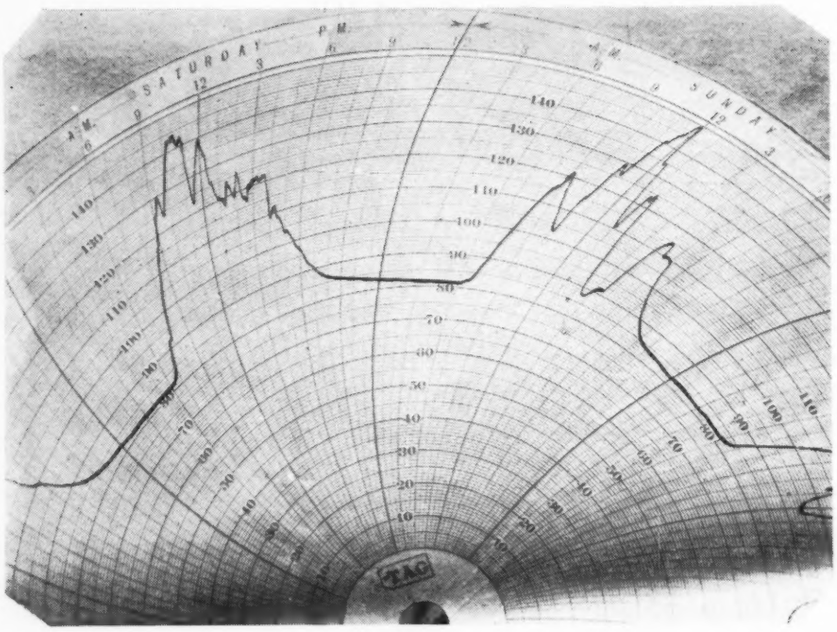


Fig. 1. Tank vapor temperatures 3 in. below roof

hydrocarbons present. This does not prevent the use of the method for oils but does make its use less satisfactory than for gasoline.

For oils in transportation the use of either the specific gravity or the vapor-pressure method is open to serious errors. This is due to the almost unavoidable contamination of the oil under test. Even if the oil block is pumped through the line between scrapers a certain amount of mixing occurs in each tank in which it is placed during transportation. Pipe-line tanks carry anywhere from a few inches to several feet of B. S. & W. plus residual oil. If a block of 80,000 bbl. of oil is passed through five different tanks en route over the test distance and each tank has four ft. of oil and B. S. & W. then possible contamination with a total of 20 ft. of oil and B. S. & W. or a total of 40,000 bbl. of mixture is possible. Even if only a small amount of contamination is obtained the effect on a small actual evaporation loss may be several times the value of the loss.

As the possible errors in making evaporation tests are so large it was decided to develop a method whereby these losses could be determined with enough accuracy to show the general trend of the values. To offset its deviation from precise results it offers speed in computing the losses. In addition to speed and a precision probably closer than most gauging tests it offers the possibility of calculating readily the losses of a wide variety of crudes under different conditions of storage, all of which could never be tested in the field.

Theory of Evaporation Loss From Closed Tanks

The evaporation of oil from closed tanks is dependent entirely upon temperature changes of the oil and vapors in the tank. Without these temperature changes the oil would develop in the vapors its equilibrium pressure and as no windage effects would be present to dissipate the hydrocarbon vapors no loss would occur from the tank so long as the vapor pressure of the oil was below atmospheric pressure.

Temperature changes occur not only daily but often several times hourly and these cause corresponding changes in the vapor pressure of the oil and the volume of the vapors. The change in volume of the vapors in equilibrium with oil in a closed tank is expressed by the differential equation:

$$\Delta V = \left(\frac{dV}{dt}\right)_p dt + \left(\frac{dV}{dp}\right)_t dp \text{ where,}$$

$\left(\frac{dV}{dt}\right)_p$ = the change in volume of the vapors for each degree rise in temperature when the system is under constant pressure. As the change in volume of an ideal gas with temperature is proportional to the change in the absolute temperature the expression $\left(\frac{dV}{dt}\right)_p dt$ can be changed to degrees Kelvin:

$$\left(\frac{dV}{dt}\right)_p dt = V \times \frac{460 + t_2}{460 + t_1} - V \text{ where,}$$

t_1 = the minimum daily temperature in deg. fahr.

t_2 = the maximum daily temperature in deg. fahr.

V = the vapor volume in cu. ft.

$\left(\frac{dV}{dp}\right)_t$ = the change in volume of the vapors caused by the change in the vapor pressure of the oil with temperature. In this the vapor temperature remains constant. The change in volume of an ideal gas is directly proportional to the change in the absolute pres-

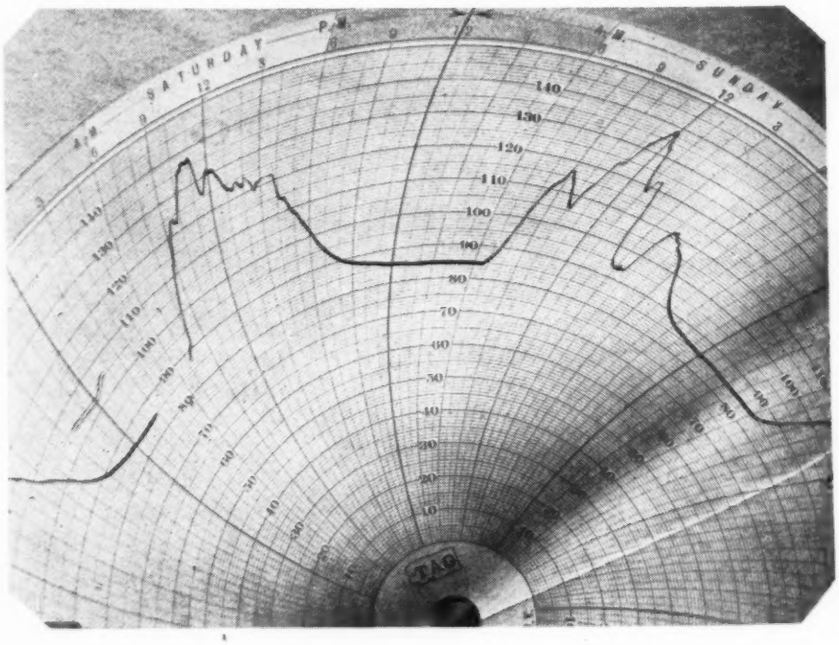


Fig. 2. Tank vapor temperatures 3 ft. below roof

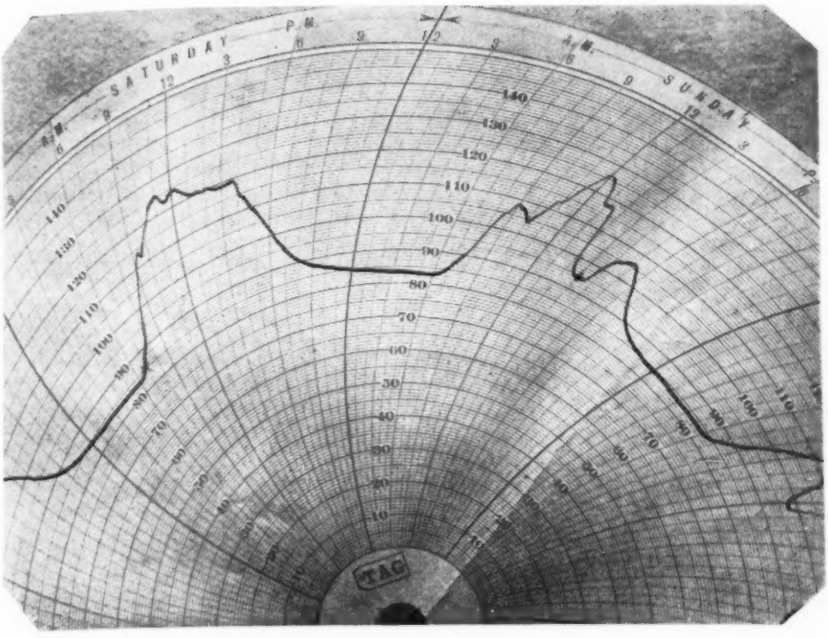


Fig. 3. Tank vapor temperatures 6 ft. below roof

sure. With the vapors in equilibrium under atmospheric pressure of 760 mm. Hg an increase in vapor pressure of one mm. Hg will at equilibrium increase the volume of the vapors by $\frac{1}{760}$. The value $\left(\frac{dV}{dp}\right)_t$ becomes $\frac{V}{760}$ where,

V = the volume of the vapor space in cu. ft.

dp = the change in vapor pressure of the oil in millimeters of mercury. The total volume of gas breathed from a storage tank is for a day of one breathing cycle:

$$\Delta V \text{ (cu. ft.)} = \left(V \times \frac{460 + t_2}{460 + t_1}\right) - V + V\frac{dp}{760}$$

The total amount of gasoline breathed from the tank depends upon the concentration of gasoline present in the vapors. If this quantity is expressed by the term gal. per M. (gallons per thousand) the total amount of gasoline in bbl. breathed from the tank in one year becomes:

Gal. gasoline lost per year =

$$\left[\left(V \times \frac{460 + t_2}{460 + t_1}\right) - V + \frac{vdp}{760}\right] \frac{\text{gal. per M.} \times 365}{1000}$$

This expression holds only for the following circumstances:

(1) That the minor daily temperature cycles occurring at short intervals are negligible in comparison with the daily maximum and minimum changes.

(2) That the measured average annual maximum and minimum temperatures closely approximate the actual daily maximum and minimum temperatures for the location for which the calculation is used.

(3) That the oil surface is kept at the same temperature as the vapors and that convection currents continually supply fresh oil to this surface so the gasoline content of the oil surface is not appreciably diminished.

(4) That equilibrium conditions exist at all times between the oil and the vapors.

It is obvious that condition (4) is not always true. If the vapor space of the tank is small then quite possibly the vapors are saturated with hydrocarbons in spite of the daily breathing that occurs. When the surface of the oil is appreciably below the tank roof then the oil vapor pressure cannot come into equilibrium with the gas vapor during the periods between the breathing of air. This is due to the slowness of diffusion of the hydrocarbon vapors throughout the vapor space even though aided by convection currents.

The general relationship that expresses the diffusion of gas from a concentrated to more dilute value of vapor pressure may be expressed by the relation,

$\frac{dc}{dh} = -kc$ where,

$\frac{dc}{dh}$ = the rate of change of the concentration of hyrocarbon vapors with distance from the oil surface.

c = the actual concentration of hydrocarbon vapors at any point.

k = a constant.

The minus sign means the concentration decreases with distance from the oil surface.

Now let C_0 = the concentration of vapors at the oil surface where $h_0 = 0$. This will be 1 or complete equilibrium. Also let

C_1 = the concentration of vapor at any distance h_1 from the oil surface. This value approximates .95 or 95 percent equilibrium at a distance dh = 1 ft. from the oil surface for the time in which the vapors have to approach equilibrium.

Integrating the equation we have

$$\int_{C_0}^{C_1} \frac{dc}{c} = -k\int_{h_0}^{h_1} dh = \text{Log } C_1 - \text{Log } C_0 = -k(h_1 - h_0) = -k\,\Delta h$$

Now letting $C_1 = .95$, $C_0 = 1.0$ and $\Delta h = 1$ ft.

$$-k = \frac{\text{Log } C_1 - \text{Log } C_0}{\Delta h}$$

$$-k = \frac{-.105 - 0}{1}$$

$k = .105$

Now using $k = .105$ the value of equilibrium constant for different distances of the oil from the tank roof becomes:

Height (Ft. from oil to tank roof)	Log C_1	C_1	Average C for Vapor Space
0	0	1	1
1	— .051	.95	.975
5	— .255	.77	.88
10	— .510	.60	.78
15	— .765	.46	.68
20	— 1.02	.36	.60
25	— 1.275	.28	.53
30	— 1.53	.22	.47

In addition to showing the value C_1, which is the equilibrium concentration immediately under the roof of the tank, the table gives the average equilibrium concentration C of the gasoline vapors in the total vapor space. This is calculated from the relationship:

$$\text{Log } C = \frac{\text{Log } C_0 + \text{Log } C_1}{2} = \frac{\text{Log } C_1}{2}$$

This value C is the fraction of equilibrium that the hydrocarbon vapors are able to obtain by virtue of insuf-

TABLE 2
Daily Temperature Range of Vapor Space of Oil Storage Tank

Roof Color / Shell Color		Aluminum / Aluminum	
	Temperature Range (deg. fahr.)		
Month	High	Low	Diff.
January	80.3	47.6	32.7
February	77.3	47.4	29.9
March	73.3	46.0	27.3
April	80.3	56.3	24.0
May	93.5	60.3	33.2
June	105.5	70.7	34.8
July	114.2	80.7	33.5
August	111.8	77.5	34.3
September	111.8	76.5	25.3
October	92.0	62.6	29.5
November	77.0	54.8	22.2
December	74.2	49.3	24.9
Average	90.9	60.8	30.1

ficient time to obtain complete equilibrium between periods of breathing. The correction factor C is used to modify both the daily vapor pressure variation (dp) in affecting volume changes as well as modifying the concentration of hydrocarbon vapors in determining the gal. per M.

The relationship for evaporation loss now becomes:

$$\text{Gal. gasoline lost per year} = \frac{\left[\left(V \times \frac{460 + t_2}{460 + t_1}\right) - V + \frac{VdpC}{760}\right] \text{gal. per M.} \times 365\ C}{1000}$$

Determination of Equation Values from Field Studies

A. *Daily temperature cycle of tank vapors.*

Data have been obtained for tanks of different color schemes showing the annual temperature cycles for Texas. The data were obtained by placing recording thermometers on tanks, the mercury bulbs being 3 in. below the tank deck and near the side of the tank. The position of the thermometer bulb was one ft. above the oil level. The data for an aluminum painted tank are given in Table 2. These show maximum average summer temperatures as high as 114.2 deg. fahr. for the month of July and as low as 46 deg. fahr. for March. The average annual maximum temperature was 90.9 deg. fahr., the minimum was 60.8 deg. fahrenheit.

Figs. 1, 2, and 3 present interesting and important relationships for the change in temperature of tank vapors. Three recording thermometers were mounted in the vapor space of an 80,000-bbl. aluminum-painted tank. The tank cone was 7½ ft. in height. The oil level was one ft. below the eaves or 8½ ft. from the top of the cone. The thermometer bulbs were placed 4 in., 3 ft., and 6 ft. below the tank cone. It will be noted that for Saturday and Sunday, July 19th and 20th, 1930, the 4-in. vapor temperatures reached a maximum of 145-150 deg. fahr., but fluctuated widely at half hour intervals. The vapors at the 3-ft. level failed by some 10 deg. to reach the same maximum temperatures but were not subject to as violent changes. The vapors at the 6-ft. depth were similar to those at the 3-ft. depth in that the minor temperature variations were not noticeable. It is to be noted that the two breathing cycles present on Sunday afternoon were effective to the 6-ft. depth.

The average temperatures given in Table 2 for the period of a year were temperatures measured 3 in. below the roof but at the side of the tank and were only one ft. above the oil surface. Thus these temperatures are thought to be nearer true average values for the oil vapors than temperatures measured just below the cone of the tank.

B. *Daily temperature cycle of oil surface.*

At the same time the data of Figs. 1, 2, and 3 were taken the bulb of a

TABLE 3
Oil and Vapor Daily Temperature Cycle
(Temperatures—Deg. Fahr.)

Shell Color	Roof Color		Tuesday Hi.	Tuesday Low	Tuesday Diff.	Wednesday Hi.	Wednesday Low	Wednesday Diff.	Thursday Hi.	Thursday Low	Thursday Diff.
Aluminum	Aluminum	Vapors	88	66	19	89	63	26	90	60	30
		Oil	88	72	16	94	70	24	92	71	21
			Friday Hi.	Friday Low	Friday Diff.	Saturday Hi.	Saturday Low	Saturday Diff.	Sunday Hi.	Sunday Low	Sunday Diff.
Aluminum	Aluminum	Vapors	110	65	45	98	63	35	106	60	46
		Oil	108	72	36	100	70	30	108	70	38

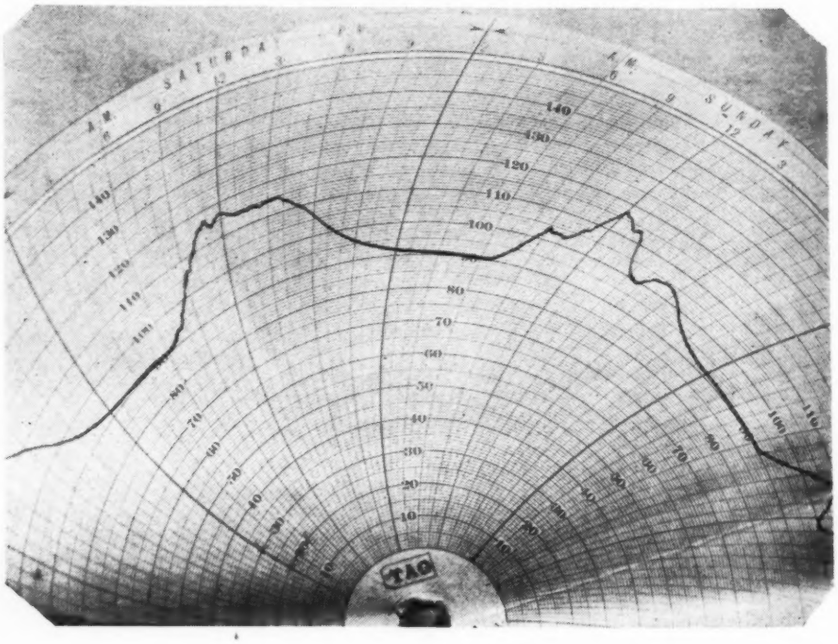


Fig. 4. Oil surface temperatures 8½ ft. below roof

recording thermometer was placed horizontally in the top inch of the oil. This oil surface was 8½ ft. below the tank roof. The data are shown in Fig. 4. It will be noted again that the temperature of the oil surface tends to follow the vapor temperatures but falls below the maximum values obtained just under the tank cone.

In order to measure more nearly accurately the skin oil surface temperature maximum and minimum thermometers were floated in the top ¼ in. of the oil. The data obtained, together with vapor temperatures one ft. above the oil, are given in Table 3. It will be noted that the two phases approximately follow the same temperature cycle. It is important that, although the vapor space temperature range was greater than for the oil, the oil minimum temperature was higher than the vapor space minimum temperature. This tends to offset the lower vapor loss that would normally result from the smaller daily oil temperature range.

C. *Volume of tank vapor space.*

The most popular size oil storage tank is of 80,000-bbl. capacity. In these calculations it is assumed the oil is stored within one ft. of the eaves of the tank. The tank dimensions are:

Height = 41 ft. 10 in.
Diameter = 117 ft.
Cone height = 7 ft. 6 in.
The volume of the cone is $\frac{1}{3} \pi r^2 h$
$\frac{1}{3}$ 3.14 $(58.5)^2$ 7.5 = 24,900 cu. ft.
The volume of one ft. of the tank is
3.14 $(58.5)^2$ 1 = 10,700 cu. ft.
Total volume = 35,600 cu. ft.

D. *Vapor-pressure curves for crude oils.*

Fig. 5 shows the vapor-pressure curves of a West Texas crude oil under varying conditions. Curve A is the vapor pressure of the oil as sampled in the pipe-line tank immediately after receipt from the field. The irregular shape of the curve and its high vapor-pressure values are due to residual methane, ethane, etc. This curve shows the effect of the tight stock tanks that are used to store this oil. Curve B is the vapor-pressure curve after 0.07 percent of the crude has been weathered. This small percentage of material is evidently all or almost all of the lighter-than-gasoline constituents. Curve B is what might be called a normal type vapor-pressure curve. Curve C is the same crude after evaporating a total of 0.15 percent or an additional amount of 0.08 percent from the condition shown by curve B. It is of interest to note that the dp for these three vapor-pressure curves for the average annual maximum and minimum temperatures are nearly the same. The data are:

TABLE 4

Curve	Vapor Pressure 90.9 deg. fahr. (Mm. Hg)	Vapor Pressure 60.8 deg. fahr. (Mm. Hg)	Difference (dp) (Mm. Hg.)
A	660	525	135
B	375	250	125
C	315	190	125

The vapor-pressure curves B and C of this crude may be considered the typical curves as curve A is too easily reduced to B or C by slight losses.

E. *Gasoline content of vapors.*

The casinghead gasoline content of the tank vapors may either be determined directly or calculated from the vapor-pressure curves.

If obtained directly the procedure is to pump vapors from the tank through a charcoal tube. The condensate in the charcoal is then distilled from the charcoal in the laboratory and measured.

If the gasoline content is based on the vapor-pressure curves care must be taken as to the curve used. In this respect the use of curve A would lead to entirely erroneous values. The values should be taken from curves such as B or C. If the data are taken from Curve B then for 1000 cu. ft. of vapors the gasoline fraction vapor pressure would be at the average temperature of

$$\frac{90.9 + 60.8}{2} = 75.8 \text{ deg. fahr.} = 300$$

mm. Hg. Then with a volume for pentane of 27.6 cu. ft. per gal. the gal. per M. of pentane in the vapors at equilibrium are

$$\frac{300 \times 1000}{760 \times 27.6} = 14.3$$

(EDITOR'S NOTE: This article will be concluded in the July 15th issue.)

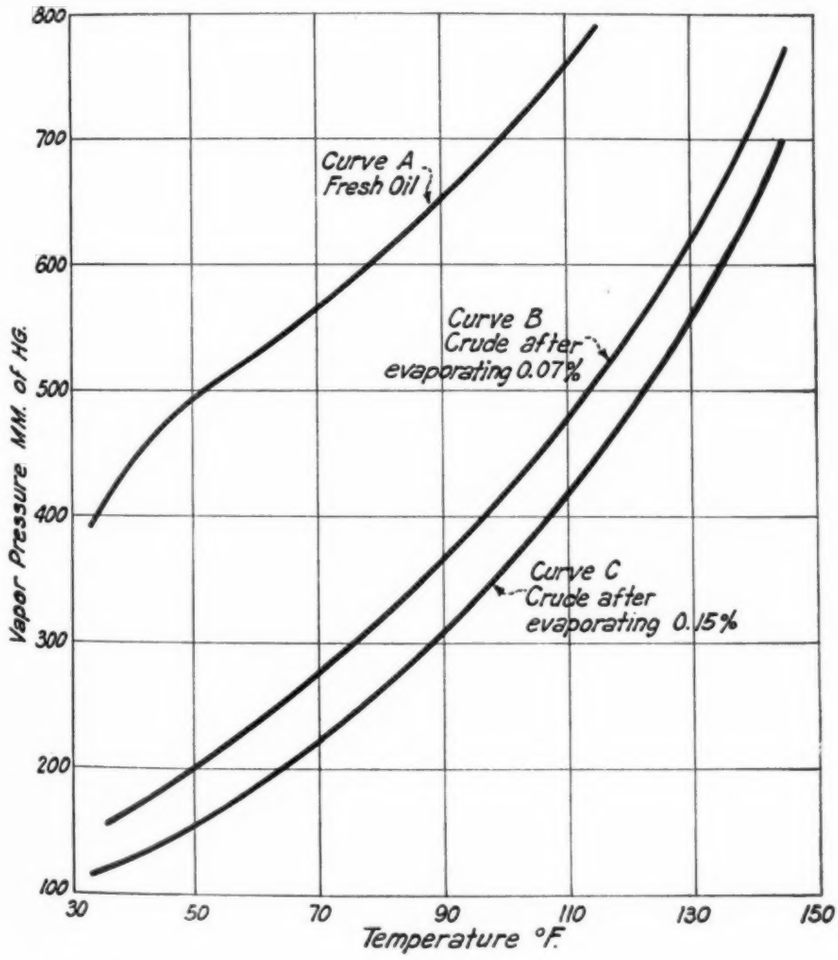


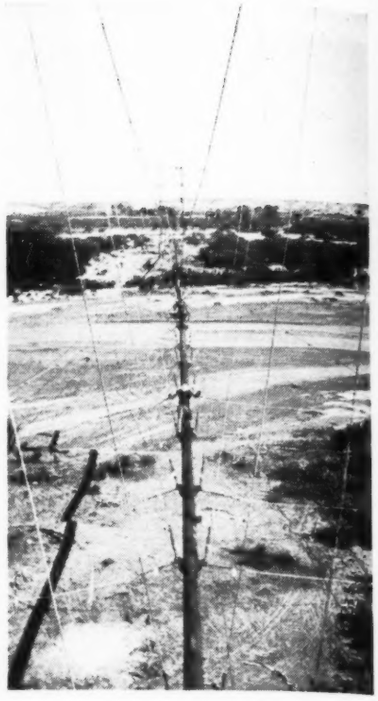
Fig. 5. Effect of evaporation loss on vapor pressure of crude oil

Pipe Line Suspension Bridge Over Wild Arizona Stream

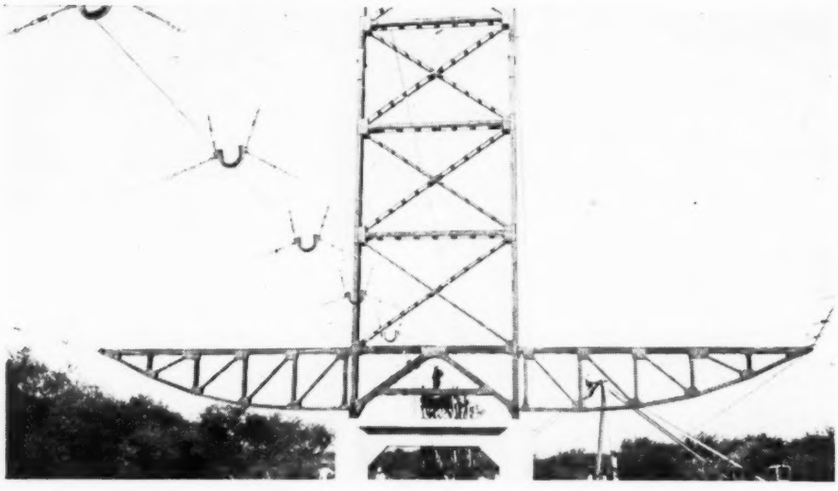
WHEN the El Paso Natural Gas Company, El Paso, Texas, was constructing a natural gas pipe line in the Southwest, just outside the town of Benson, Arizona, a small stream had to be crossed. Ordinarily such a stream would have presented no problems and the pipe line would have been laid on the stream bed. This stream, however, goes on a rampage at certain seasons of the year and assumes such proportions as to sweep everything in its path. The presence of this danger caused the company to carry the pipe line across the river by means of a suspension bridge.

On each bank of the stream, directly opposite and 1000 ft. apart, was constructed a steel tower 85 ft. high. Each tower was mounted on a cement foundation. Behind each tower temporary platforms were constructed and the sections of pipe for welding were hoisted to the platforms. Welders and helpers, riggers, and supervisors worked on the platform, Lindewelding the pipe and pushing it out on the suspended pipe saddles. The pipe was welded and fed out as follows: 250 ft. from one side, then 500 ft. from the other side, and finally 250 ft. from the first side. A cable from the opposite shore was used to help pull the welded pipe out from each platform as men steered it through the saddles. Horizontal guy wires kept the saddles from moving too far out of position, so the pipe could slide through them.

The welding on the platforms was done by two operators as follows: One operator welded from top to bottom on the right side of a joint, while the other welded from the middle to the bottom and from the top to the middle on the left side. The average time per completed weld was ten minutes.



Above—This view taken from one of the towers shows men steering the pipe in the saddles as it is being hauled out by a cable. A tie-in weld in the center of the span completed the job



Left—Showing the design of the structural steel work and the method used for securely guying the saddles.

Below—Pipe sections were hoisted to platforms at each end of the bridge, welded, then fed out

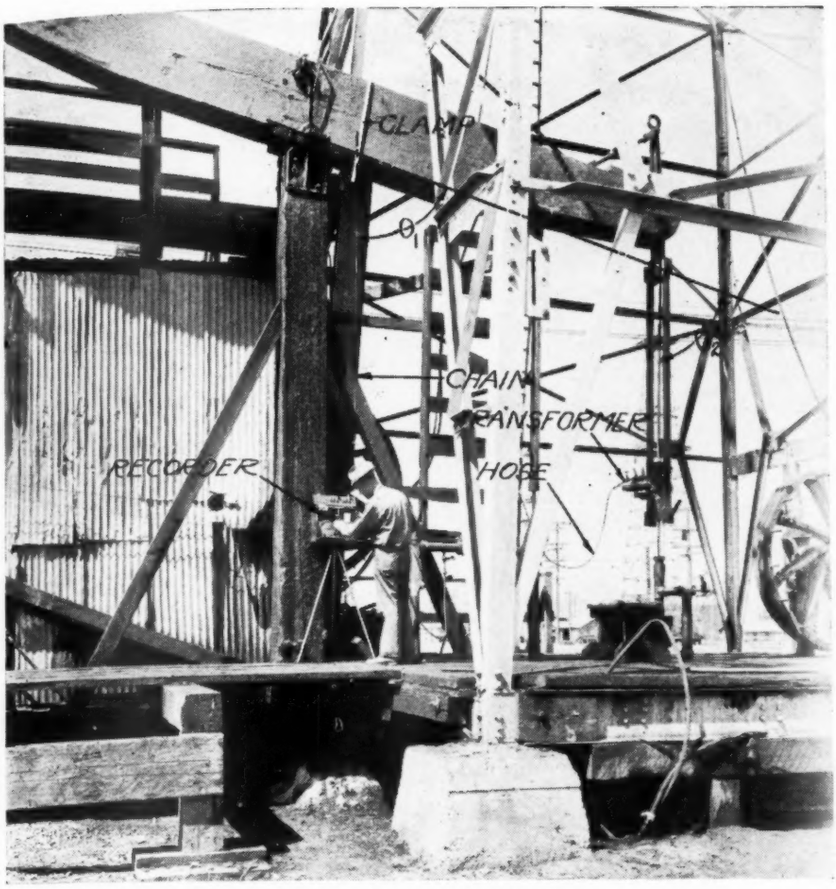


Fig. 1. Dynamometer installation

found the information afforded by the instrument so important in maintaining proper operation of wells that use of the instrument is a routine matter.

PLACE OF THE DYNAMOMETER IN THE TEST PROGRAM

Throughout the productive life of any oil well, it is desirable that up-to-date information be available on: (1) well performance; and, (2) equipment performance. By the former is meant "those sub-surface characteristics . . . which are divorced from any consideration of the method by which the oil is brought to the surface"[1] Equipment performance refers to the characteristics of the particular installation used for lifting the fluid. In rod-operated pumping wells, both of these performances may be computed directly from data obtained by the instruments especially built for the purpose[2]:

1. *Sub-surface pressure recorder or fluid-level recorder:* Well performance: datum pressure productivity index, potential, etc.
2. *Polished-rod dynamometer:* Surface equipment performance: loads, torque, efficiencies, etc.

Practical Dynamometer Tests ‡

PART 1

By H. N. MARSH* and E. V. WATTS*

ABSTRACT

THOUGH dynamometers have been used for a number of years and excellent papers have been published on special applications, little has been published concerning everyday uses and value. This paper is of text-book nature—showing the place of the dynamometer in well-testing problems, listing the principal types, presenting data on the accuracy of the hydraulic type, outlining uses of dynamometer data, and describing field and office procedure. Examples are included, and beneficial results cited.

INTRODUCTION

Recording dynamometers were first used for testing the performance of rod-operated pumping oil wells in 1923; and, although the instruments have been generally so used since 1929, little has been published on the practical aspects of such tests. Excellent papers have been written on special applications of dynamometers, so that the impression may have been created that they are primarily for occasional use by the research worker. On the other hand, some companies have found the information afforded by the instrument so important in maintaining proper operation of wells that use of the instrument is a routine matter.

EDITOR'S NOTE:

Because it is a valuable reference on the practical aspects of dynamometer tests and their application in routine producing operations for determining the performance of rod-operated pumping wells, this paper, presented at the Mid-Year Meeting of the A.P.I., Wichita, Kansas, will be published in full, in two parts. Part two will appear in the July 15th issue.

3. *Pump dynagraph*†: Sub-surface equipment performance: plunger stroke, conditions at pump, etc.

Regardless of the desirability of such comprehensive information, the time required to run all three types of instruments makes costs seriously objectionable. It is ordinarily necessary to limit the test program to the procurement of data which are readily obtainable and most essential to a study of the individual well. If maximum production efficiency is to be secured, then some knowledge must be available on

*General Petroleum Corporation of California, Los Angeles.

‡Paper presented at Eighth Mid-Year Meeting, American Petroleum Institute, Wichita, Kansas, May 24, 1938.

†The words "dynamometer" and "dynagraph" are currently used interchangeably. Throughout this paper "dynamometer" will refer to the surface instrument; "dynagraph," to the subsurface instrument.

[1]B. P. Kantzer and E. G. Trostel, "Oil-Well Performance: A Discussion and Proposed Terminology," *Drilling and Production Practice*, 1937, 118.

[2]Ned Clark, H. F. Dangberg, and P. L. Kartzke, "Understanding Pumping-Well Problems," *Oil and Gas Journal*. 36 (51) 35 (1938).

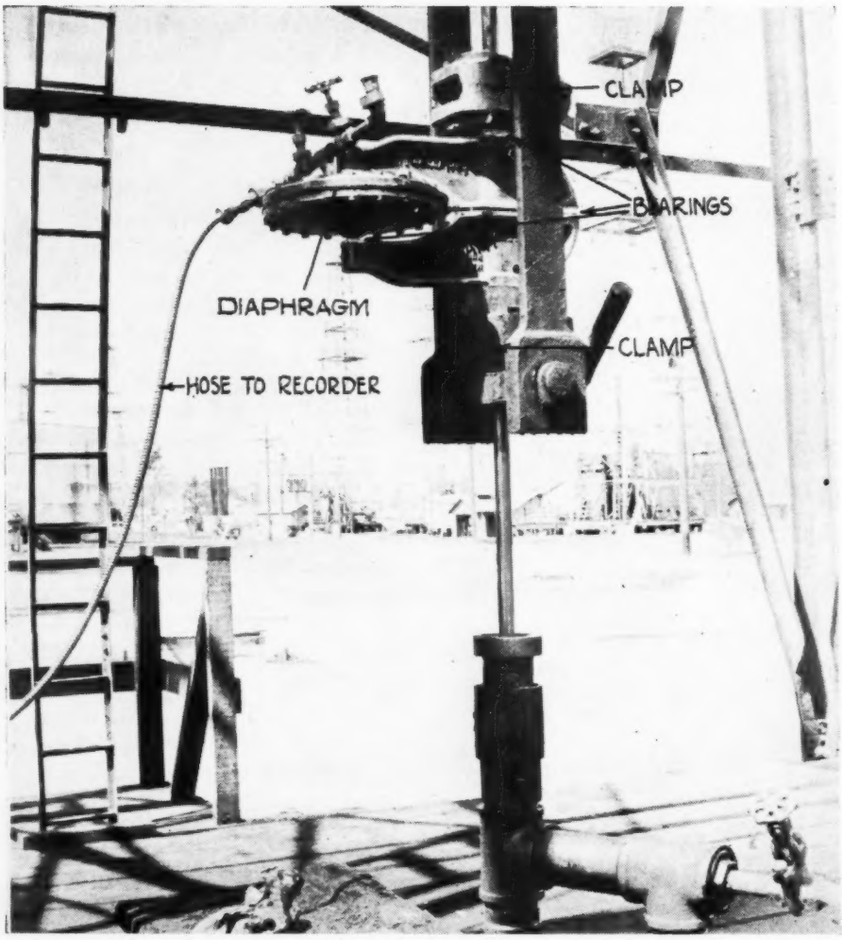


Fig. 2. The transformer

surface conditions. Toward this end the dynamometer is indispensable. Equally important, however, is the fact that the dynamometer can be used to estimate the nature of sub-surface conditions by unique effects which may be observed as the polished rod. Three to five accurate and complete tests can be made easily in one day. Therefore, because it is the least expensive to run and because the data it provides are broadest in scope, the dynamometer is logically the key instrument in the testing program.

Far from being a cure-all, the dynamometer does not give results which are always conclusive. Further tests with the other instruments are not to be discouraged. Such supplementary study may be centered on a problem well, or used as a periodic check on deductions from surface data.

TYPES OF POLISHED-ROD DYNAMOMETERS

The dynamometer is essentially a device for determining the load on the polished rod as a function of polished-rod position. There are two general forms: (1) the strain gauge type, with several modifications; and, (2) the diaphragm hydraulic type. Although the latter is the only one with which the authors have had much experience, most of the paper is equally applicable to both types.

Diaphragm Hydraulic Type

The diaphragm hydraulic type consists chiefly of two parts: the transformer unit for converting the polished-rod load into pressure, and the recorder for registering this pressure. As shown in Figs. 1, 2, and 3, the transformer unit is placed on top of the regular polished-rod clamp. A second clamp, tightened above the unit, transmits the load through the unit to the hanger when the lower clamp is released. The unit itself is composed of two beams pivoted at one end, with a diaphragm mechanism between them at the other end, whereby a constant portion of the instantaneous polished-rod load is converted into a pressure which may be transmitted to the recorder through a flexible hose. The recorder is essentially a steam-engine indicator, motion of the drum being obtained by clamping a chain to the walking beam near the center bearing.

Accuracy of Hydraulic Dynamometer

Intrinsically, the hydraulic dynamometer has an accuracy sufficient for all practical purposes. Friction in moving parts is small, as shown by the fact that little hysteresis is observed in calibrating even the weakest indicator spring. In Fig. 4 points lie on a straight line within plus or minus one percent of the full-scale deflection. Inasmuch as the load is applied perpendicularly to the diaphragm, this calibration is independent of the volume of fluid in the transformer, up to the point at which the diaphragm takes up its slack.

Error in the recorder itself probably does not exceed two or three percent[3] at even the highest pumping speeds, inasmuch as this device is primarily designed for recording pressure variations in engines operating up to 350 revolutions per minute. It has been found, however, that the loads registered by the recorder lag behind the polished-rod load depending on the type of connecting hose used. The magnitude of the lag, of course, varies inversely as the speed of sound (pressure waves) through the water in the hose which, in turn, is a function of the material of which the hose is constructed. If a rubbed tube is used, this velocity is small—resulting in an appreciable lag. On the other hand, copper tubing gives good results, due to the fact that the speed of sound is approximately 3000 ft. per second. If the tube is not more than 20 ft. long, then the lag is less than 1/150th of a second. However, the copper breaks easily unless protected with welder's rubber hose. Flexible steel tubing, which is generally used in preference, gives long life and equally satisfactory results.

Conclusions concerning lag are based on tests in which the recorder was mounted directly upon the transformer and used on a well pounding fluid, thereby creating sharp impulses. Tubes of the various materials and of the same length that would be used to the normal location of the indicator were looped from the diaphragm to the indicator with valves arranged so that successive cycles could be recorded on the same card either directly to the indicator or through the various kinds of hose. Impulses traveling through the metal tubes arrived essentially at the same time as those traveling direct, while those traveling through rubber tube arrived appreciably later.

Like any other instrument used for reasonably accurate measurements, the dynamometer must be handled intelligently. A few simple precautions,

[3] J. A. Meyer, *Power-Plant Testing*, 2nd edn., 140-1.

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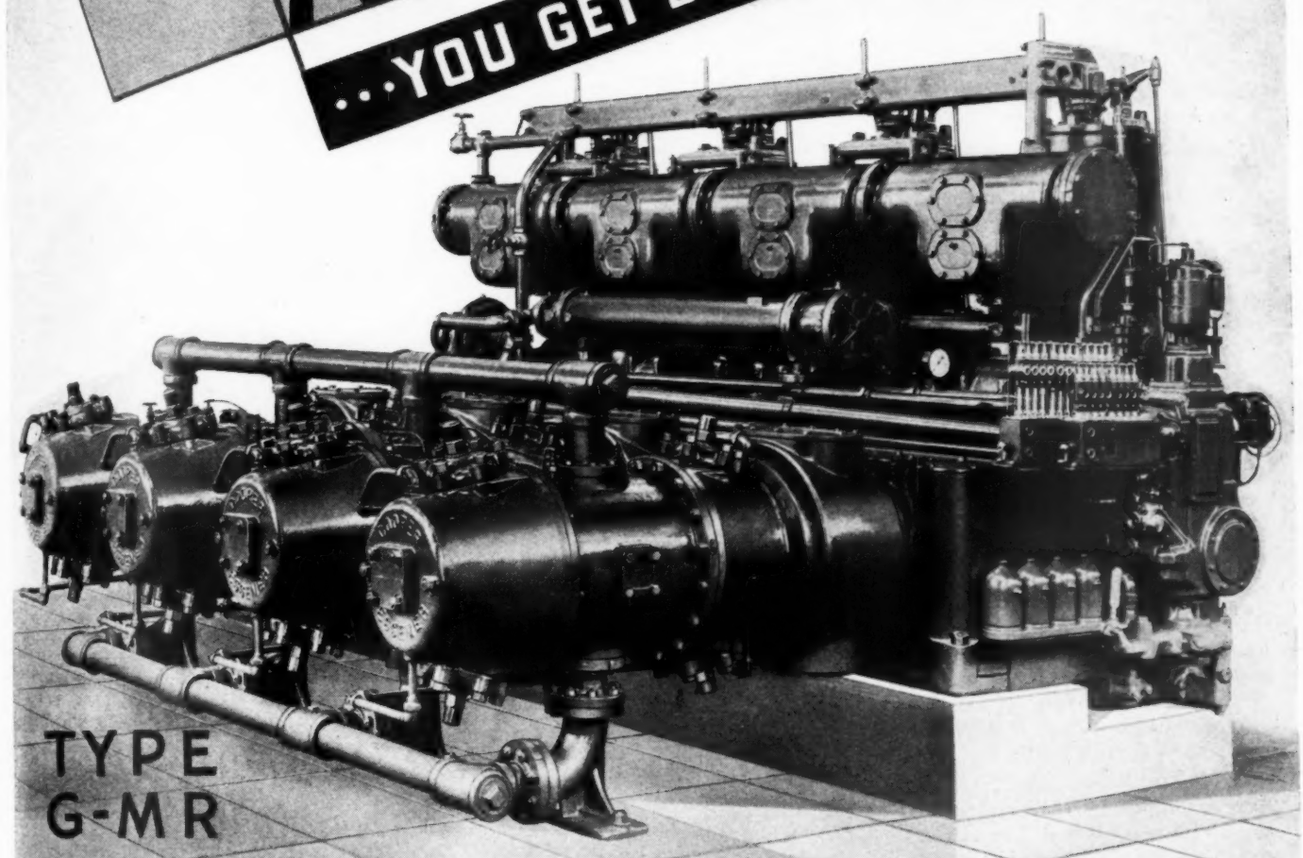

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therefore, should be observed to eliminate errors:

1. The transformer must be nearly level to avoid eccentric loading.
2. All air should be bled from the hose and diaphragm unit in order that the pressure impulses will not be cushioned.
3. The unit should be filled with sufficient water to keep slack in the diaphragm.
4. The bottom clamp should be completely free of the rod when released, to prevent a portion of the load being shunted around the transformer. (A little gasoline and a few hammer blows usually eliminate sticking.)
5. The point of attachment of the chain used to reciprocate the drum should be so selected that a card at least 3 in. long is obtained. Also, angles θ_1 and θ_2 should be equal, as shown in Figs. 1, 2, and 3. If the recorder is placed so that the chain is vertical, this point will fall on a line joining the center bearing and the stirrup bearing. In case the beam has a horsehead and swings through an angle greater than about 30 deg., it is desirable that a miniature horsehead likewise be provided for the chain.

USES OF DYNAMOMETER DATA

Before field procedure is discussed, it may be well to consider in more detail what can be learned from the dynamometer test. As has already been suggested, the information can be divided into two parts: (1) that which concerns the performance of equipment; and, (2) that which indicates sub-surface conditions by the effects observable at the polished rod. The first category includes what may be called for convenience "definite results," as they are obtained through comparatively simple calculations—with little occasion for elaborate theory or difference of opinion. The second includes equally important items; but, as more judgment and experience are involved, they will be termed the "inferred results."

Definite Results

The following can be readily computed from the data and, hence, constitute "definite results."

1. *Maximum load,* of obvious significance with respect to sucker rods and pumping machine.
2. *Range of load,* of significance with respect to sucker-rod failures and beam failures. Second only in importance to maximum load.
3. *Number of applications of load per cycle:* Some cases of impact loads are so severe that there may be several peak loads comparable with the maximum, so that for each cycle the rods and pumping machinery are subjected to several severe loads.
4. *Minimum load* indicates whether increased speed would cause the beam to get ahead of its load.
5. *Horsepower at polished rod:* With other readily-available data, this permits calculation of the two following quantities.
6. *Above-ground power efficiency,* which is polished-rod horsepower divided by horsepower at prime mover.
7. *Below-ground power efficiency,* which equals theoretical work of lifting fluid divided by dynamometer horsepower.
8. *Correct counterbalance,* which is merely the height on the force scale to the center of gravity of the loop on the dynamometer card, and tells not only whether the counterbalance is correct but, if not, what is needed.
9. *Gear torque,* which is of great importance in determining whether the gear is overloaded.

Inferred Results

Perhaps the main conclusion to be established concerning sub-surface conditions is the location of the fluid level. Should the fluid level be at the pump, it may be possible to improve the rig operation without loss of production.[5] On the other hand, if the fluid level is above the pump, then it is desirable to determine the reason for this condition. In general, high fluid can be attributed to one or more of three causes: (1) low volumetric efficiency of pump due to an ineffective gas anchor, large clearance space, poor valves, entrance losses, or slippage; (2) tubing or shoe leaks; or, (3) good volumetric efficiency but insufficient pump displacement. Which of these conditions exists can be inferred from several sources of information:

1. Dynamometer test:
   a. Shape of dynamometer card.
   b. Below-ground power efficiency.
2. Volumetric efficiency, estimated by any of several methods.[5, 6, 7, 8]
3. Production data on well, gas-oil ratio, cut, etc.
4. Production history of well.
5. Previous experience:
   a. With similar wells.

[5] H. N. Marsh, "High Volumetric Efficiency in Oil-Well Pumping and Its Practical Results," *Proc. A.P.I.* 12M (IV) 47 (*Prod. Bull.* No. 207) (1931).

[6] C. J. Coberly, discussion of paper by H. N. Marsh, "High Volumetric Efficiency in Oil-Well Pumping and Its Practical Results," *Proc. A.P.I.* 12M (IV) 57 (*Prod. Bull. No.* 207) (1931).

[7] Robert William Rieniets, "Plunger Travel of Oil-Well Pumps," *Drilling and Production Practice,* 1937, 159.

[8] Emory Kemler, discussion of a paper by W. E. Gilbert, "An Oil-Well Pump Dynagraph," *Drilling and Production Practice,* 1936, 114.

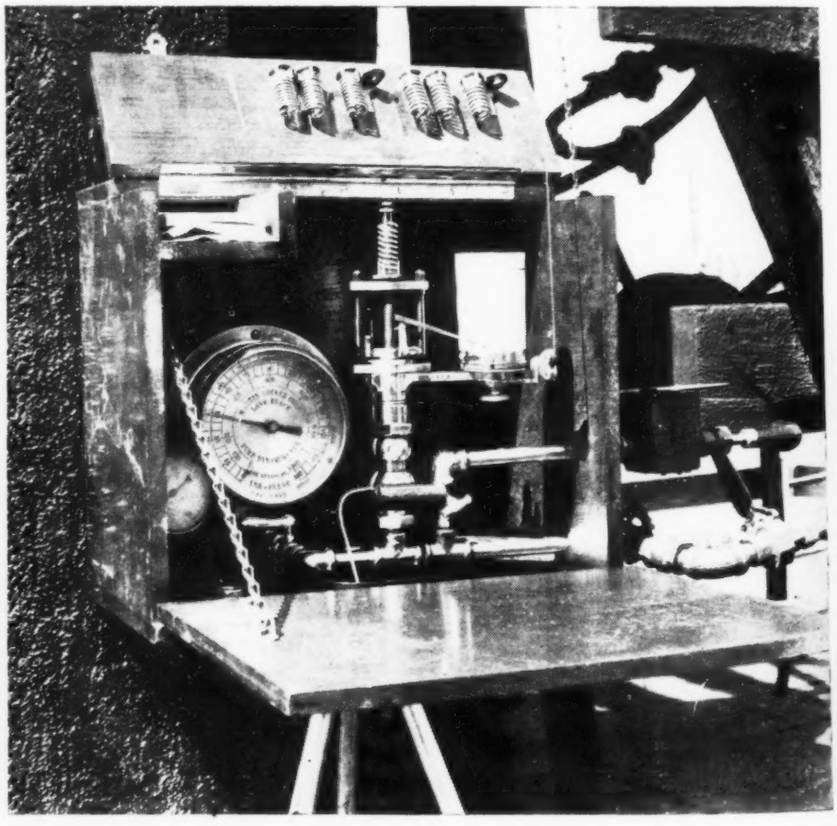

Fig. 3. The recorder

Lufkin SELECTION— INSURES PUMPING Perfection

CHECK THESE Prerequisites BEFORE PURCHASING

1. Herringbone gears . . quiet, efficient, with strength in abundance and designed for maximum compactness.
2. Large, oversize bearings, adequate to withstand the severe shocks of variable pumping loads.
3. Positive and efficient lubrication to all working parts.
4. Center-line beam motion to insure greatest possible efficiency and uniform polish rod motion.
5. Counterbalance crank of Rotary type — simple, rugged and easily adjustable to correct position.
6. Field service to supervise and check installations — to insure complete operating satisfaction.

Simple, but important prerequisites, govern the selection of perfect pumping equipment.

These prerequisites are incorporated into the design of Lufkin equipment and are familiar "ear marks" to the experienced engineer. They form the basis of comparison for all types of pumping equipment.

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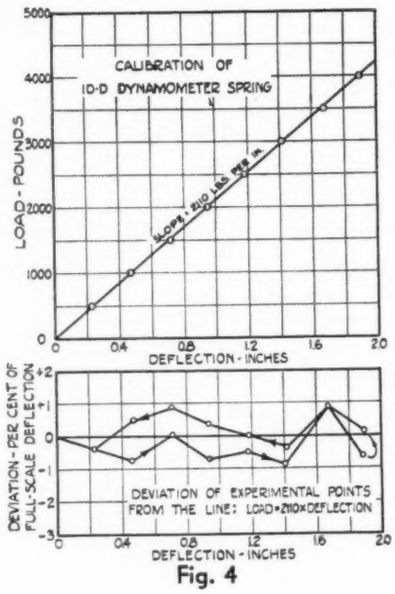
LUFKIN PUMPING UNITS

LUFKIN UNITS are manufactured in Lufkin, Texas, by the Lufkin Foundry & Machine Company. Branches in principal oil centers

b. With particular well, old tests, etc.

c. With particular equipment in use, gas anchor, style of pump, etc.

The analysis of the dynamometer card as one of the steps in estimating sub-surface conditions can be briefly described. The ideal card is rectangular in shape, with a downstroke load equal to the weight of rods in oil, and an upstroke load equal to the downstroke load plus the hydrostatic pressure of fluid acting on the gross plunger area. For comparative purposes, *it is essential* that these loads be computed and plotted on the cards actually obtained by the instrument. In Fig. 5 are illustrated the effects on this ideal card of rod and tubing stretch, mechanical friction, free gas in the pump, high fluid level, and dynamic forces. Despite the fact that dynamic forces at ordinary pumping speeds may distort the card considerably[9] and obscure some of the other effects, fluid pound resulting from gas in the barrel is usually quite evident. The absence of this pound, of course, suggests that the fluid level is above the pump, whereas its existence implies that either the well is pumped off or the gas anchor is not entirely effective. Cards taken at slow speed, to eliminate dynamic forces, are of further help in estimating which of these conditions exists—particularly in shallow wells with large plungers. Table 1 summarizes the analysis by which the dynamometer and other readily-available data can be used to isolate the most probable sub-surface condition without recourse to a sub-surface test.


CALIBRATION OF
10-D DYNAMOMETER SPRING
LOAD - POUNDS
SLOPE = 2100 LBS PER IN.
DEFLECTION - INCHES
DEVIATION - PER CENT OF FULL-SCALE DEFLECTION
DEVIATION OF EXPERIMENTAL POINTS FROM THE LINE: LOAD=2100×DEFLECTION
DEFLECTION - INCHES
Fig. 4

that the downtime will be as short as possible, preferably not more than a minute or two. If no delay is experienced in making preparations, then normal pumping conditions will be quickly resumed. As a check, however, cards should be taken on the recorder at intervals until there is substantially no change in their size and shape. When it is certain this condition has been reached, the test card may be taken. Several cycles should always be superimposed and averaged on any one card, as rod loads sometimes change from stroke to stroke, even though the operation is considered steady. This is especially true if the pump handles varying quantities of gas. Data taken at approximately the same time as the test card include power input, strokes per minute, turns per minute of motor, and revolutions per minute at various crank positions. This much of the test provides sufficient information to compute the definite results, but cards for other operating conditions are helpful in determining sub-surface conditions and methods for improving operation.

For example, a card taken at very slow speed will be little affected by the forces of acceleration and fluid friction. A sufficiently slow speed can be obtained on most rigs by shutting off the power and scribing the record just before the machinery comes to rest. As shown in Fig. 5, the comparison of the maximum and minimum loads on this record with the theoretical loads will indicate the presence of a high fluid level or excessive mechanical friction. Of course, these are compensating forces; and, in making the comparison, consideration must be given to other factors, such as the drift of the hole

TABLE 1
Showing Some of the Sub-surface Conditions which May Be Inferred from Surface Data

Surface data:				
Dynamometer card taken at slow speed	Fluid Pound Indicated	Fluid Pound Indicated	No Fluid Pound Indicated	No Fluid Pound Indicated
(Refer to Fig. 5)	(Cards 8, 10, 12)	(Cards 8, 10, 12)	(Cards 7, 9, 11)	(Cards 7, 9, 11)
Dynamometer card taken at slow speed	Similar to card 3 or 4	Similar to card 5 or 6	Similar to card 5	Similar to card 5
(Refer to Fig. 3)				
Volumetric efficiency	Low	Low	High	Low
Below-ground efficiency	Low	Low	High	Low
Gas-oil ratio	Low	High	Low	.....
Cut	.....	Low	.....	.....
Daily production	Regular, moderate decline	Irregular, slight decline	Regular, slight decline	.....
Probable sub-surface condition	Fluid level at pump, displacement can be reduced	Fluid level above pump due to ineffective gas anchor	Fluid level above pump due to inadequate displacement	Fluid level above pump due to tubing or shoe leak

FIELD PROCEDURE

In addition to the dynamometer itself, the following equipment is necessary for the average test:

Instrument	*Use*
1. Watt hour meter or vacuum gauge	Power input to motor Power output of engine*
2. Revolution counter	Average speed of prime mover
3. Tachometer	Speed variation of prime mover
4. Thermometer	Temperature rise of motor
5. Stopwatch	Strokes per minute, turns per minute, etc.
6. Flexible rule	Stroke length, pulley sizes, etc.

The routine of installing the equipment should be well planned in order

[9] J. C. Slonneger, "Vibration Problems in Oil Wells," *Drilling and Production Practice*, 1937, 179.

*The torque-manifold depression characteristics can be obtained from the manufacturer of the engine. D. G. Kingman, "Application of Multi-cylinder Gas Engines," *Proc. A.P.I.* 17M (IV) 14 *(Prod. Bull.* No. 217) (136).

JELL-ABILITY

JELOX enables you to control the colloidal properties of your mud system within the limits which experience has taught are best. The granular particles of JELOX wet quickly and completely, forming a smooth, creamy paste, free from clots or lumps. The suspension and wall conditioning qualities found in JELOX are available in no other form of bentonite . . . yet it costs no more. Thus the continuous growth in popularity of JELOX beyond all comparison.

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and the possibility of excessive leakage in plunger and valves.

Frequently a good estimate of the height of fluid above the pump can be obtained by shutting in the casinghead and taking cards while the gas pressure builds up. If the fluid level can be depressed to the oil intake, then the point at which the well starts to pump off is clearly shown on the record as the familiar fluid pound; therefore, it may be said that the head of fluid normally on the intake is equivalent to the rise in pressure observed at the casinghead.

Finally, where equipment permits, it is desirable to take cards at various pumping speeds in order to predict the effect on rod loads of permanently increasing or decreasing the speed.

Although a reference line is provided on all cards by taking a record with the indicator open to atmospheric pressure, it is necessary to make a correction for the weight of the transformer and the static head of water in the connecting hose. This is most easily done at the conclusion of the test by operating the rig with the upper clamp released and the lower clamp tightened. The so-called "zero line" obtained may then be measured off from the atmospheric line, and plotted on the other cards.

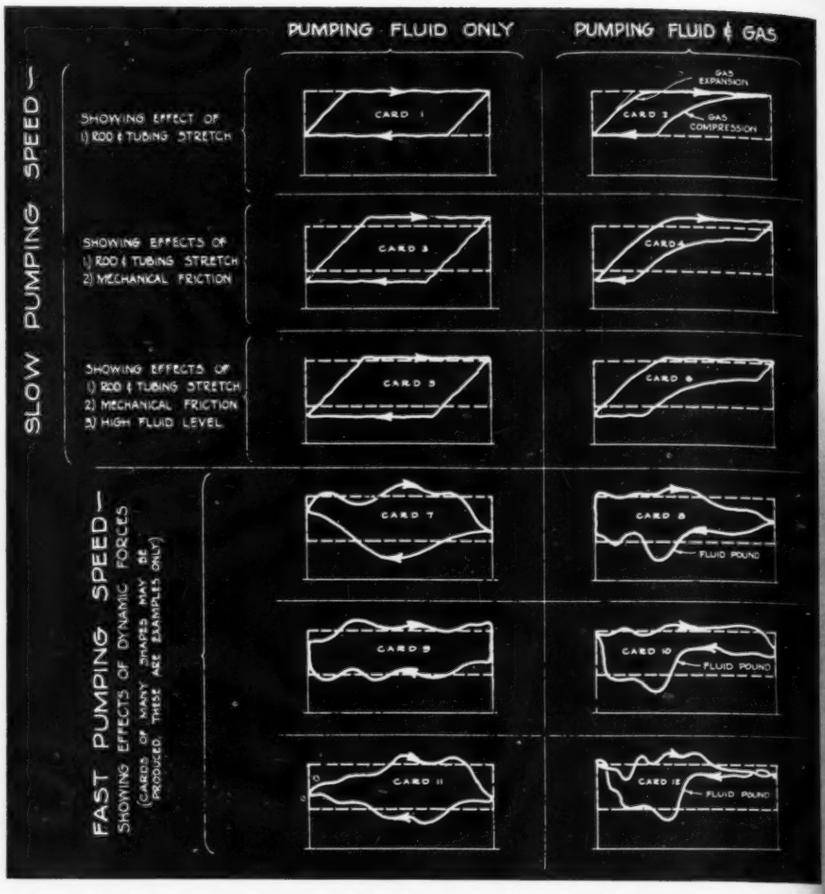

Fig. 5. Effects on the dynamometer card of common influences. Dotted lines on cards indicate position of the ideal loop: Downstroke load = weight of rods in oil. Upstroke load = downstroke load plus fluid load on gross plunger area

New Dew-Point Apparatus Increases Efficiency of Operation of Gas Transmission Lines

EFFICIENCY of operation of natural gas transmission lines should be increased as the result of the development by the Bureau of Mines, Department of the Interior, of a dew-point apparatus suitable for use with natural gases under pressure. The temperature to which a gas may be cooled before water will begin to condense may be determined with this apparatus. This information is useful in the prevention of water condensation, which interferes with the flow of gas in the lines and, in combination with constituents of the gas, may form solid gas hydrates.

All natural gas, as it is produced from the well, carries some water in the form of vapor. The dew point, or temperature at which this water vapor will start to condense, frequently is higher than the temperature of the pipe line it enters. When this condition exists, some of the water vapor will condense to liquid as the temperature of the gas drops to the temperature of the pipe line. The apparatus just announced by the Bureau of Mines is useful in determining the dew point of the gas at the well head or along the pipe line, thus making it possible to know whether there is any likelihood that water will condense from the gas.

The gas from a compressor station usually is saturated with water vapor at a temperature considerably above the temperature of the pipe line it enters; consequently, unless the gas is dried a considerable amount of water is likely to condense in the line. Many pipe-line companies are installing equipment to remove a part of the water vapor in the gas to avoid condensation in their transmission lines. The dew-point apparatus is of value in determining the efficiency and correct adjustment of such equipment.

The apparatus is suitable for working pressures to 2500 lb. per sq. in., but is equally satisfactory for use at lower pressures. It is simple in design, compact, readily portable, and easily operated. Dew points may be determined with an accuracy of 0.2 deg. fahrenheit.

The dew-point apparatus is described in Report of Investigations 3399, entitled "Bureau of Mines Apparatus for Determining the Dew Point of Gases under Pressure," by W. M. Deaton and E. M. Frost, jr., of the Bureau's oil and gas laboratory at Amarillo, Texas. This report may be obtained without cost from the Bureau of Mines, Washington, D. C.

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"GIVE us a cement as strong as 'Incor'—but one that sets slowly and flows freely, even at 200 degrees," Oil Men told us. That is to say, a true Portland cement, with the added quality of timed cementing action. We answered with 'Starcor', the high-temperature cement.

'Starcor' is free-flowing . . . the set is slow enough to get it into place with time to spare . . . yet, even in deep, hot holes, it gains strength rapidly.

Use 'Starcor' for the hot spots, and give heat the horse-laugh. For wells of moderate depth and low temperature, it's 'Incor'*. And for work above-ground, Lone Star. Portland cements, all—backed by a quality record that covers more than a quarter century.

*Reg. U. S. Pat. Off.

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USE 'STARCOR'—for deep wells, high temperatures, extra sulphate resistance.

USE 'INCOR'—for wells of moderate depth, and low temperatures.

Wells Drilled Through Mine Tunnels Present Unusual Cementing Problem

Special method of cementing devised to protect workers in mines penetrated by wells

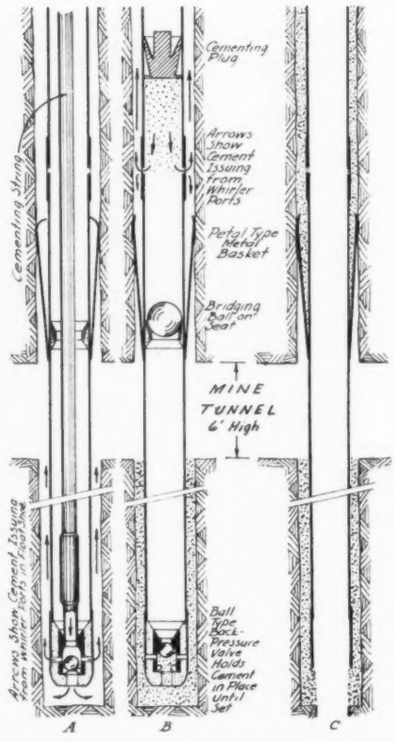
By WALLACE A. SAWDON
Petroleum Engineer, Los Angeles

IN drilling some locations in the Centralia district in Illinois the well bore passes through mine tunnels that lead into mines that are being worked. To protect the lives of the miners the state has passed a law that requires all operators drilling into shafts or tunnels to cement casing from the roof to the surface of the ground and then drill 75 ft. below the floor of the tunnel and cement another string of pipe. One string of casing can be saved, however, by cementing in two stages, and one such method recently developed is illustrated by the accompanying sketch.

In the first well cemented by this method, the roof of the tunnel was struck at 547 feet. When the bit broke through the roof, circulation was naturally lost. Hole was then drilled through the floor of the tunnel for approximately 100 feet. The hole was 11 in. in diameter and a string of 8⅝-in. casing was made up and run to a point just above bottom as shown at "A" in the drawing.

A float shoe is used on the casing to provide a back-pressure valve to keep the cement in place behind the pipe upon completion of the first cement job. This shoe is made with left-hand square threads to connect a 2½-in. cementing string, on the bottom of which is an expansion joint.

A bridging collar is placed in the casing string just above the roof of the tunnel. A 4½-in. loaded ball is dropped on the seat of the collar after the lower cement job is completed and the cementing string is removed from the hole. The hole through the collar is 4 3/32 in. in diameter and permits running the cementing string and expansion joint in and out of the hole.


Cementing Plug
Cementing String
Arrows Show Cement Issuing from Whirler Ports
Petal Type Metal Basket
Bridging Ball on Seat
MINE TUNNEL 6' High
Arrows Show Cement Issuing from Whirler Ports in Float Shoe
Ball Type Back-Pressure Valve Holds Cement in Place Until Set
A
B
C

Illustrating a method of cementing in two stages, which saved one string of casing

Just below the bridging collar is a petal-type metal cementing basket reinforced to support the cement, which it alone must support because there is no fluid in the hole to carry the weight of the cement slurry as in ordinary cement jobs where a basket is used. Above the basket is a collar provided with ports for passage of the slurry in the second cement job. A perforated nipple can be substituted for this collar if desirable.

The lower cementing job is performed as indicated by "A." After the casing is landed, the cementing string is run-in and screwed into the shoe. Cement slurry is then pumped to fill the space behind the casing to the floor of the tunnel. The cementing string is pulled and the bridging ball dropped down the pipe to seat on the bridging collar as shown in "B."

The upper cementing job is then done by use of the regular plug method, the cement passing through the ports in the collar and filling the annular space behind the casing from the metal basket to the surface of the ground. After the cement has set the hole is drilled-out and drilling is continued as shown in "C."

The first basket used for this type job supported 540 ft. of cement around 8⅝-in. casing in an 11-in. hole. The total weight of this column of cement exceeded 15,000 lb. but no leakage around the basket was reported. Some companies use 10¾-in. strings in 13¼-in. hole and one company would probably set 7-in. in 8¾-in. hole.

Connections on Vibrating Oil Machinery

By W. F. SCHAPHORST

VIBRATING oil-field and refinery machinery often causes trouble in several ways, one of the most serious being the breaking of pipe and other connections. The vibration of the machinery is sufficient to cause crystallization in the metal and as a result the pipe soon fractures at the point of connection.

It has been found that breakages of this kind most commonly occur in connections that are made "too high." The most satisfactory solution is to make the connection at a point near the foundation. The explanation is that the amplitude of vibration is always least at the foundation and greatest in the parts of the machine that are most remote from the foundation, precisely as in a tuning fork. Thus the top of an electric motor or refrigeration compressor "moves" farther, as it vibrates, than does the base.

The logical place for connecting pipes, cables, ducts, etc., is therefore as near the point of least vibratory motion as practicable—near the foundation. This applies also to flexible types of connectors, whether metallic or nonmetallic, that are made especially to resist vibration, because even they have their bending limitations.

and-
"by his Violin
the world knew him"
Years, even centuries, have but added to the prestige and standing of the law-men of long ago who spent their lives creating "Fine Violins." Into the materials at hand went a personal element —one that identified the maker with the product.
Hughes Rock Bits have always been more than just so much steel, moulded to a specific design. For almost 30 years they have represented the personal efforts of men who are willing to abide by the Old Violin Maker's theory—"by our work they shall know us."
We believe there is not a driller on a derrick floor today who would not immediately recognize that he had a Hughes "Tailor-Made" Rock Bit on Bottom, by its performance.
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Cementing of Wells in East Texas Field to Reduce Volume of Water Produced

Failure of formation to resist entrance of cement slurry presents peculiar problem

By RALPH H. KING

MANY wells in the East Texas field, particularly in the vicinity of the town of Gladewater and along the west edge of the field, are producing an excessive amount of water. Water constitutes as much as 98 percent of the fluid produced by some wells, and many wells produce fluid containing more than ten percent water.

The present reduced allowable production, the realization of the importance of the water as the driving force moving the oil to the wells, and the increasingly difficult problem of water disposal have impressed operators with the necessity of excluding the water wherever possible. One major company plugs-back every well producing as much as 15 percent water, but most operators have been reluctant to spend any money on work-over jobs, and as a result the wells are in such bad condition that water exclusion is difficult.

In many wells the casing is so poor that it will not stand the pressure exerted upon it when the pressure on the cement is maintained by closing the casinghead. Hence most cementing is done using a cement retainer to maintain pressure on the cement. A few short strings have been set and perforated but that method has not been popular.

It is generally agreed that in cementing a well to exclude water a pressure of 2500 to 3500 lb. is necessary in order to be sure of obtaining a satisfactory shut-off. Some plugs introduced at a lower pressure have excluded the water but there can be no assurance of satisfactory results at the lower pressures.

In many of the wells several hundred sacks of cement could be introduced without developing the desired pressure. The quantity of cement used seems to be unimportant compared with the pressure at which it is forced into the formation.

The problem to be solved by the operators, manufacturers of cement and equipment, and well-cementing companies is the development of a method of cementing that will permit the introduction of cement at high pressure but in reasonable quantity.

It was at first thought that the lack of resistance to the flow of cement into the formation could be correlated with the permeability of the sand, but apparently that is not uniformly true. Rather the condition seems to correlate with the amount of water produced by the well.

It is possible that production of a large volume of water results in the formation of solution channels, so that the original permeability of the sand is increased. If that were true the tendency of the sand to take cement at low pressure might correlate with the induced permeability as well as with the amount of water produced.

There is the further possibility that the water removes all traces of oil from the sand and wets the sand thoroughly, so that when the cement slurry is introduced it readily flows through the passages that would ordinarily offer considerable resistance to flow. That is, the tendency of the sand to take cement at low pressures may be regarded as the result of change in the surface tension of the fluid wetting the sand.

In attempting to solve the problem, those persons interested in the work appear to have assumed that the cause of the trouble is the high induced permeability of the sand. No other possibility has been given serious consideration. On that basis there have been two approaches to the problem.

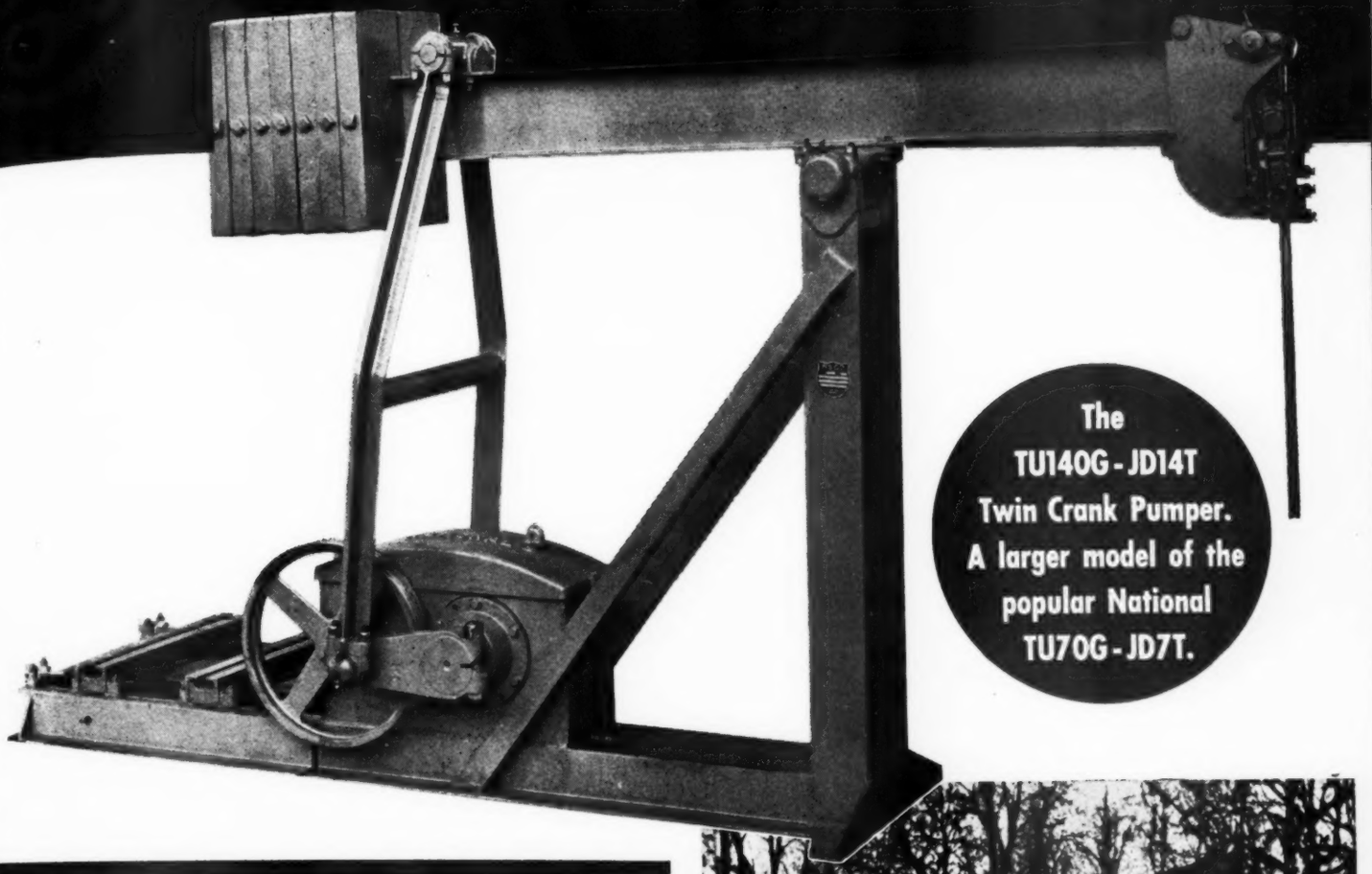
One theory of operation is that a small batch of cement introduced at a relatively low pressure will enter the largest channels and will, if allowed to set under pressure, close them against the entry of any batch introduced later. Subsequently introduced batches will encounter greater and greater resistance to flow as the successively smaller channels are filled, and eventually all channels will be effectually blocked, and all water excluded.

The other theory of operation is that a gel-forming material mixed with the cement and allowed to set briefly after penetrating the larger channels will prevent further flow of cement in the large channels and as a result the slurry will be forced into all pores, sealing-off the water.

In practice, both methods are still in the experimental stage. The optimum quantity of cement to be introduced in each batch, the number of batches, and the type of cement have not been finally determined. The optimum quantity of gel-forming material to be added to the cement has not been determined. Nevertheless the results obtained are much more satisfactory than those obtained using the conventional method, despite the fact that the wells now being cemented are more difficult to treat. It is difficult to learn what success has accompanied the use of either method, because commercial organizations are naturally reluctant to divulge information that they feel should come from the operators for whom the work is done and the latter hesitate to recommend or condemn a process on the basis of the results obtained in their wells.

Prophecy is futile, but it seems probable that when a consistently satisfactory process is finally developed, as it undoubtedly will be, it will make use of extremely thick slurry and some kind of material for plugging the large channels, at least temporarily, and surface tension effects will be taken into consideration. The final perfected plan will be the result of close cooperation of manufacturers of cement and cementing equipment, well-cementing organizations, and engineers of producing companies.

another NATIONAL UNIT PUMPER FOR THE SHALLOWER FIELDS



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Designed to meet the requirements of low first cost for those shallower fields where either temporary or permanent single well pumping is desirable. It is economically moved and installed, can be adapted to high as well as low speed prime movers, and is made to operate with little attention and maintenance.

BRIEF SPECIFICATIONS

Nominal H. P., API, at 20 spm	7.44
Overall Gear Ratio	24.9
Maximum polished rod stroke	32"
Well and working centers	48"
Maximum counterweight effect at maximum stroke	4036 lbs.

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DIVISION OFFICES: FT. WORTH, TEXAS; TULSA, OKLA.; TORRANCE, CALIF.
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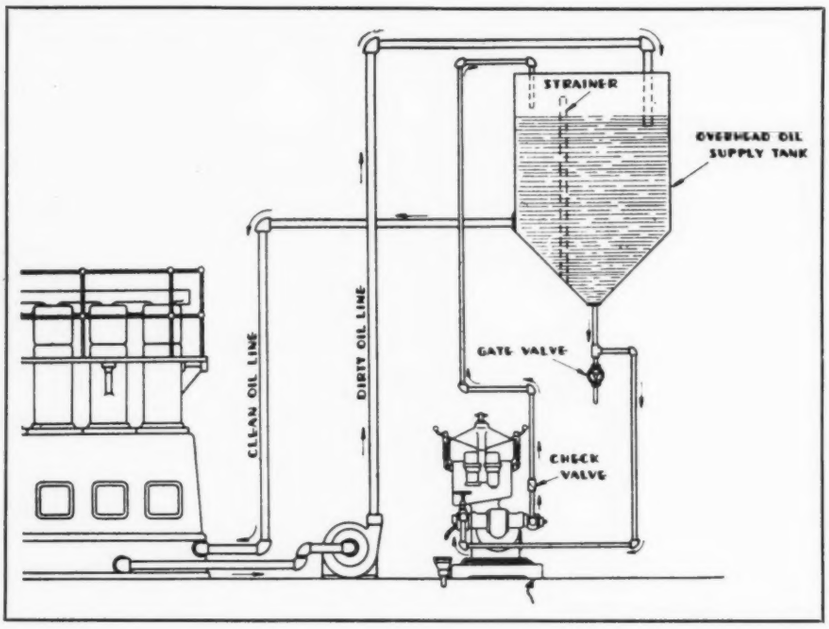

Fig. 1. Centrifuge arranged to draw oil from an overhead tank

By
ORVILLE ADAMS

Centrifuging, chemical treatment, and use of activated clay are the methods found practicable in salvaging used oils

Reclaiming Lubricating Oil From Diesel Drilling Engines

OPERATORS of Diesel power units on drilling rigs discard much used lubricating oil or use it on chains and gears where a less expensive product might serve as well. They frequently ask whether this oil could be economically reclaimed for re-use in the engines. It is general practice to reclaim used lubricating oil in the large stationary plant. By means of purifiers such as are employed in stationary Diesel plants the lubricating oil used in high-speed, portable equipment can be reclaimed and again used in the engines.

Such purification apparatus need not be expensive, when results obtained are considered. When the oil has been used a certain length of time, so much carbon, dirt, and metallic particles that are not removed by the filter accumulate that the oil is no longer suitable for use. This oil, however, is not worn out. Tests have shown that used oil contains 98 to 99 percent good oil when drained from the engine lubricating system, and is unaltered by service except for a slight amount of oxidation and the usual contamination. The problem of purification is the removal of the one to two percent of undesirable material that forms or accumulates in the lubricating oil.

What purification methods will avoid waste of otherwise good oil that is discarded?

Systems of Purification

Several systems of oil purification and reclamation have been developed, and many of these systems have long been used in Diesel plants. These systems may be divided into three classes, i.e., the centrifuge, chemical treatment, and systems using activated clay. The centrifuge and activated clay systems are so designed that they can clean the oil in batches or continuously, whereas chemical systems are designed for batch operation only.

Fig. 1 illustrates a simple system employing a centrifuge to purify the oil. The oil is pumped to an overhead tank and is returned to the engine by gravity. The centrifuge draws oil from the tank, cleans it, and returns it to the tank; this process is continuous, based on the observed fact that impurities may be removed as rapidly as they accumulate. The lubricating oil will be maintained in good condition if the rate of oil removal and treatment is sufficient.

Operators may delay removal of dirty oil from the crankcase until the engine is seriously damaged. When purification is used, this source of trouble is eliminated. It is necessary to stop the centrifuge at intervals and clean the dirt and sludge from the bowl; the frequency of this operation will depend upon the amount of sludge and solid matter in the oil. Centrifuges are constructed so that the bowl can be easily and quickly removed and cleaned. Much less time is required than for draining the crankcase of an engine and refilling with new oil.

One of the reasons for continuous centrifuging is that the dirty oil should be hot when passed through the centrifuge. High oil temperature will decrease the viscosity and specific gravity. A decrease in specific gravity increases the difference in weight between the oil and the dirt particles to be removed, and makes the action of the centrifuge more effective. The decrease in viscosity is particularly important as it decreases the resistance to movement of the dirt particles through the oil. A centrifuge unit having pumps for handling oil is shown in Fig. 2.

It might be expected that centrifugal machines would be provided with heating units, to be operated by electricity, gas, hot water, or steam. One outfit has a gas heater connected to a bypass section of the exhaust line and the lubricating oil is pumped through a compartment the walls of which absorb heat from the gases that flow through the gas compartment. The amount of gas bypassed is controlled by a thermostat to regulate the heat. From the information at hand it appears that such equipment would be economical in connection with engines as large as 100 horsepower.

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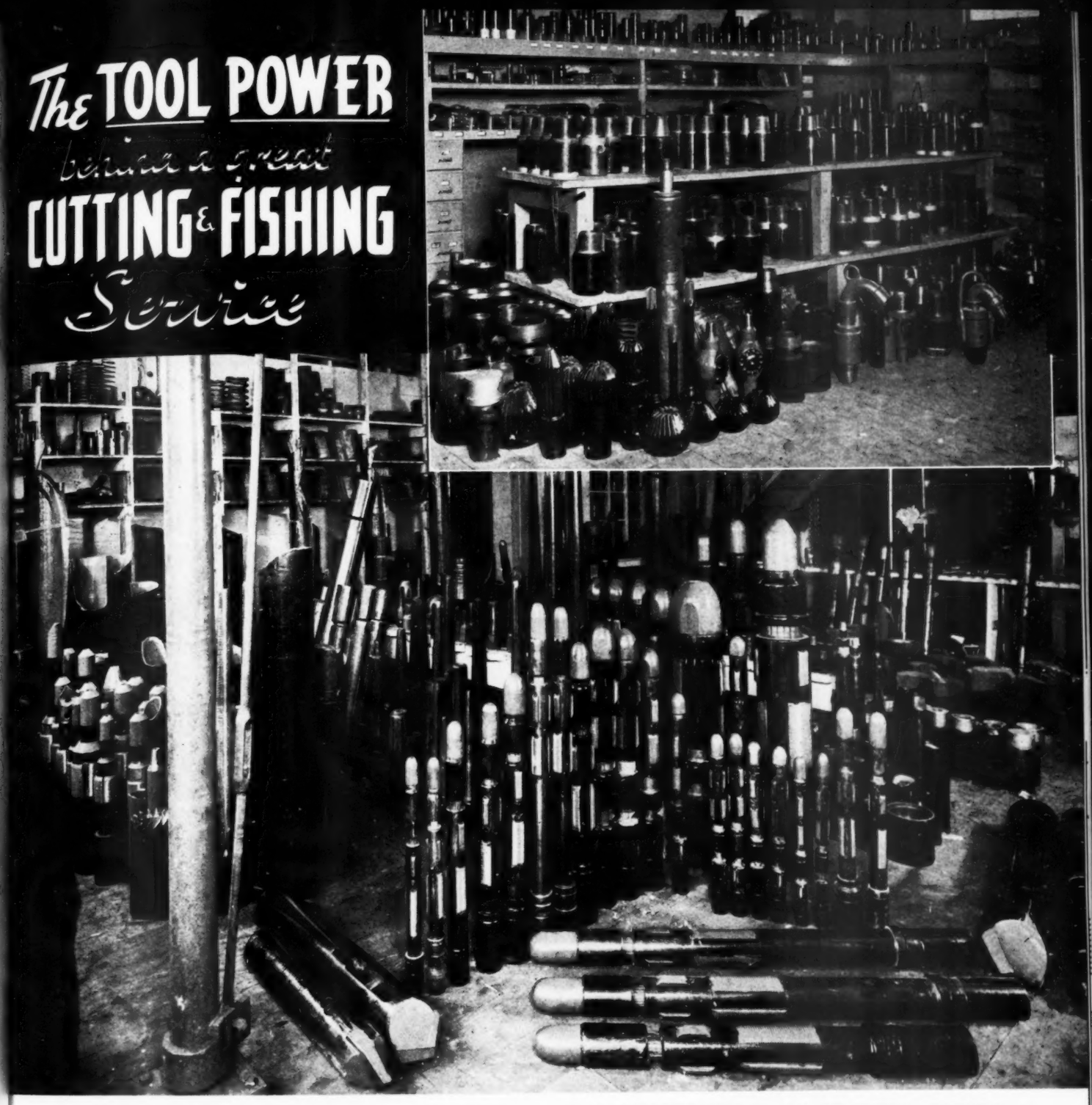

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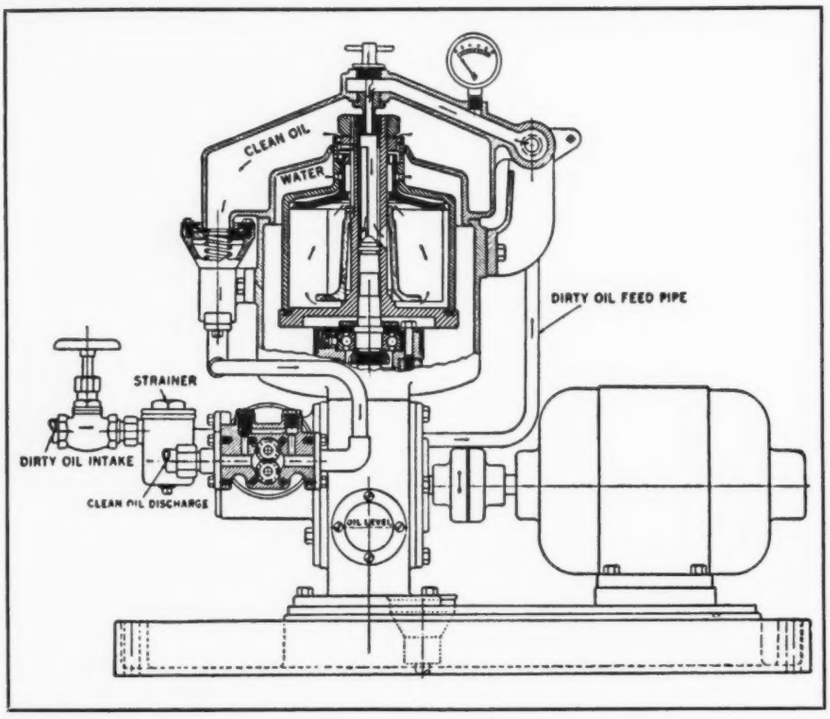

Fig. 2. Centrifuge unit having pumps for handling oil

Chemical Treatment

The chemical treatment involves the use of a coagulant to precipitate the foreign matter in the oil. The treatment tank usually consists of a jacketed container arranged to permit removal of clear oil at the top. The hot water from the engine is circulated in the jacket to maintain the temperature at 180 deg. fahrenheit. The lower half of the tank is filled with hot water and the upper half with oil, which is added from a side connection on the tank.

After the coagulant is added, the mixture is agitated ten or 15 minutes by compressed air or steam. The mixture is then allowed to settle for at least 24 hours, during which time the foreign matter adheres to the coagulant, forming a layer of sludge between the water and the clean oil. When the separation has been completed, the water is drained back into the inner tank, causing the clear oil to rise and pass over the oil overflow edge into an outlet pipe that leads to a clean oil tank. This system is suitable if the operators find it more practical to have a central service shop to which the oil is brought from various power units.

Activated Clay Method

Several systems using activated clay to filter the foreign matter from the oil have come into general use. In one system, Fig. 3, the vacuum pump G draws the dirty oil from the storage tank through a preheater C and delivers it to an electrically-heated still D. Here the diluting water and fuel are vaporized at relatively low temperature. The vapors pass to the condenser E, and the oil, which is free from the liquid impurities, is drawn by the vacuum pump from the bottom of the still and discharged through a vapor trap H to a three-stage gravity filter I. Reclaimed oil drains by gravity to the storage tank J.

Another system employing filtering earth operates in a similiar manner. The dirty oil is forced into the heating chamber by means of a float-controlled internal-gear pump, which automatically stops when the proper quantity of oil has been delivered. The filter earth is added through an opening in the top of the apparatus. An electric heater, controlled by a thermostat, raises the temperature of the oil to the required degree. While the oil is being heated, the filter clay and the oil are continuously agitated. It requires about one and one-half hours to attain the proper temperature and mixture conditions. The thermostat shuts off the heater, which is a signal to the operator that the batch is ready for filtering.

During the heating period, any water and light fuel oil fractions that may be mixed with the lubricant are vaporized and pass through a condenser, the non-condensible gases being vented. The filtering earth in contact with the oil neutralizes any acid present.

The chief function of the chemical and activated clay systems is to remove the colloidal carbon and restore the oil's original color. This colloidal carbon and acid are not removed by the centrifuge, but are removed by the activated clay method; many operators, however, assert that the colloidal carbon does not interfere with the function of the lubricating oil in the engine.

The use of such equipment is not a cure-all. The operator must establish a regular schedule and technique of oil reclamation. Unless an exact routine is followed, it is to be expected that the oil will become contaminated and loaded with impurities to such an extent that it may not be worth cleaning, and result in damage to the engine.

There are two kinds of foreign mat-

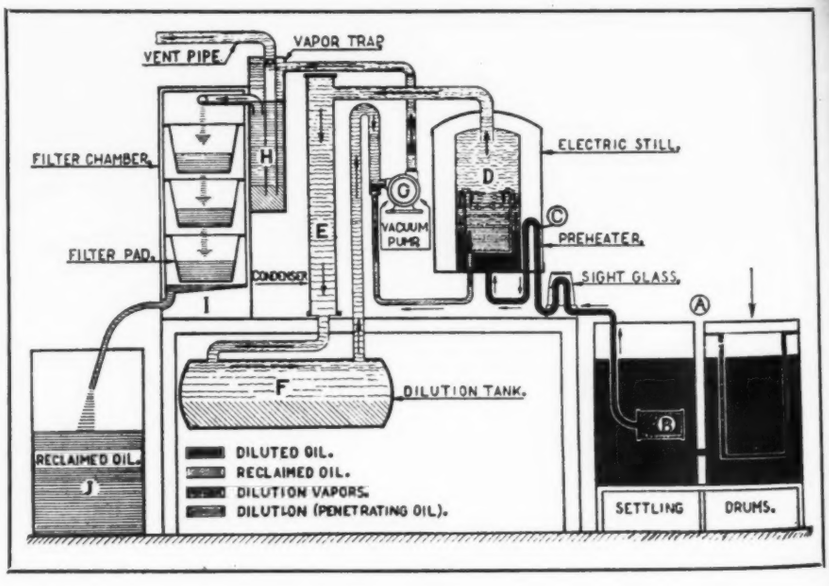

Fig. 3. Diagram of oil reclaimer

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ter to be removed from the dirty oil. What is known as "sludge" consists of solid matter formed by oxidation of lubricating oil. Deposits comprise all foreign matter found in the crankcase not resulting from sludging, and colloidal carbon.

Unburned residue from the fuel is a large part of the deposits. Slight deposits of unburned fuel are inevitable, and they consist of tarry or carbonaceous material, indistinguishable from lubricating oil sludge resulting from oxidation. This matter, together with any matter not removed by the filters, and the deposits of metallic particles resulting from wear of the rings, liners, and bearings, must be removed periodically if the oil is to be re-used, although the quantity of all such matter does not exceed one or two percent of the total. It is evident that any system that will satisfactorily remove such foreign matter at a reasonable cost for apparatus and operation is worth consideration.

It is particularly important to remove the acid from such oils, regardless of the subsequent use of the reclaimed oil, in order to prevent corrosion of machine parts.

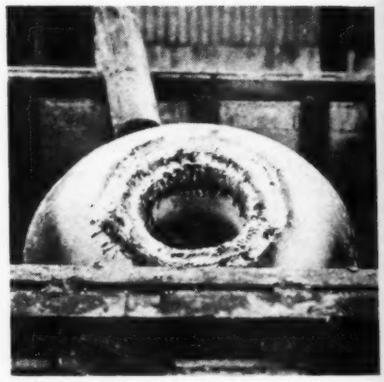
Recent improvements in lubricating oils, particularly the resistance to deterioration by sludging and oxidation, have increased the stability of oils so that they can now be used for a much longer period without formation of excessive sludge than was possible under the same conditions ten years ago. The "anti-sludge" oils are now available for any type of Diesel engine.

The use of highly refined oils and the use of filters and reclaimers have greatly reduced the lubricating oil cost of Diesel and gas engine operation.

In one large plant where such reclamation has been carefully applied, not one gallon of used oil has been discarded in five years, the only loss being the oil that passed the rings and was consumed in the combustion chamber or lost through the exhaust ports. The efficiency of the system, the low rate of cylinder wear, and the saving in lubricating oil have shown the value of the system, not only in reduced wear on the engines, but in reduction of time spent in cleaning and overhaul, prevention of stuck rings, and reduced bearing wear.

Repairing a Natural Gas Engine Head

Close-up of the bronze-welding operation



Firing head repaired and ready for lime cooling pit

IN one compressor station, an economy is being effected by bronze-welding cracked firing heads from 1300-hp. natural gas engines. These firing heads become cracked from overheating and from lime deposits that accumulate in the water-cooling passages. The heads cost about $200 new, but using the plant's own welding equipment the welding operators can do the repair job for approximately $40.00.

The firing head is an alloy casting weighing 500 lb., 44 in. in diameter and 18 in. thick. Around the water-cooling jacket the wall is three in. thick, and it is through this thickness at the top of the head that the crack occurs.

Preheating Furnace

The welding shop is equipped with a home-made preheating furnace constructed of brick held in place by angle iron and flat strip welded together. It is fired by natural gas burners, which project into the furnace through its sides. After the crack has been veed down to the water jacket, the firing head is preheated slowly for three hours. This length of time has proved most satisfactory for uniform expansion.

Bronze-Welding Operation

The gas is then shut off and the operator starts bronze-welding in the furnace, using a high-quality bronze welding rod, and completes the job in about two hours.

Following the welding operation, the head is brought to an even heat and then placed in a lime pit for slow cooling over a period of three days. This long cooling period insures uniform contraction, refines the grain structure, and results in the removal of most of the original casting strains.

Prior to placing a firing head back in operation on a natural gas engine, the repaired section is chipped smooth with a chisel and any small rough spots are filed. Excellent results have been obtained by this repair procedure and one repaired head has been reported in satisfactory service for more than 5000 hours. It is now standard practice for this company to send in damaged heads from all stations along the pipe line to be repaired by this process.

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BLEACHING CLAY

PART 10 (Concluded)

By RAFAEL FUSSTEIG

IN the early days of the oil refining industry spent bleaching clay was considered a waste product. The use of bleaching in the refining of oils resulted in considerable loss of the oil, caused by the adsorptive action of the clay. The first step taken to prevent these losses was the extraction of the adsorbed oil by means of a proper solvent. Gasoline was chosen as the solvent. Several methods were used in which gasoline was treated either in a liquid state or in a fresh condensed state.

It has been stated, however, that the gasoline treatment did not remove all the oil. According to the further studies of the investigators, benzol, chloroform, carbon tetrachloride, etc., were found to have better power of extraction than gasoline. This was the reason that many refineries in Europe tried to extract the adsorbed oil by means of other organic solvents. Such extraction has been carried out and certain clays have been proved suitable for the repeated adsorption process; that is to say, certain clays have been partly regenerated.

This caused many chemists to regenerate bleaching clay. In other words, the aim of the oil refining industry was to remove all substances from the microscopic channels of the bleaching clays. Parsons removes all adsorbed substances from the bleaching clay by using a mixture of alcohol and acid. According to the writer, the acid transforms the strong adsorbed basic coloring matter into coloring salts, the latter being soluble in alcohol. In that manner the basic coloring matter can be removed from the interior of the microscopic channels. According to Thiele and Cordes[1] the regeneration of the spent clays can be so carried out that the oil is removed from the microscopic channels by means of gasoline, after which the basic coloring matters are then removed by means of carbon disulphide.

These methods, although they improve the activity of the spent clay to a certain degree, cannot completely empty the microscopic channels. For this reason steam is used, the most simple method consisting in blowing steam through a layer of the spent clay[2]. Hindelang[3] has improved upon this method: the spent bleaching clay is first pressed for 15 minutes, it is then pressed for about an hour at a temperature of 100 deg. cent., and then treated with steam. The "Plausons Forschungsinstitut" at Hamburg, Germany, recommends a procedure[4] consisting of treating with superheated steam with or without addition of an inert gas. Of course, the temperature of the steam should not exceed the temperature at which the bleaching clay will decompose.

Allen and Holde[5] patented a similar procedure. The spent bleaching clay is treated in an autoclave with superheated steam at a temperature of 180 deg. centigrade. The oil and coloring matters are removed, and, according to these investigators, this procedure results in a complete regeneration of the spent clay.

In seeking additional methods of regenerating bleaching clay, it has been found that the use of hot air or flue gas aids greatly. Manning[6] regenerated spent clays by graining or pulverizing them, then submitting them to the action of a hot air stream until the latter causing an oxidation or reduction of the adsorbed compounds. Reford[7] proposes first to moisten the spent clay with water, and then submit it to the action of a hot air stream until the clay is dried. Following this the dried clay is treated with superheated steam. Bolton and Lush[8] regenerate the activity of Fuller's earth by treating it with superheated steam at a temperature of 230 to 300 deg. centigrade. The Filtrol Company[9] regenerates artificially-activated bleaching clay by treating it with superheated steam, and then passing a stream of oxygen through the layer, burning all adsorbed compounds in the microscopic channels.

The action of hot air, superheated steam, and flue gas has never been able to restore the original activity of the spent bleaching clay. It is true that they have better penetrated into the interior of the microscopic channels of the bleaching clay, but it is also true that these agents have not improved the activity of the spent clay. The reason for this is the formation of powdered carbon particles during the oxidation processes of the adsorbed compounds, these carbon particles being then adsorbed by the same microscopic channels of the spent clay.

A very interesting process for removal of adsorbed oils from the interior of microscopic channels consists in the displacement of the oil by water. According to Lewite[10], this displacement can be carried out economically when the adsorbed oils have not quite fully penetrated into the interior of the clay structure. If large quantities of hot water are used, two-thirds of the adsorbed oil can be removed. The Floating Metal Company[11] has patented a process consisting of mixing the spent clay with water, and blowing air through this mass. This causes the adsorbed oil to rise to the surface of the water; however, these methods do not restore the activity of the clay because, as just mentioned, only a part of the adsorbed oil is removed, and the microscopic channels must be thoroughly emptied.

The regeneration of spent bleaching clay can also be accomplished by means of acids and alkalies. Of course, the adsorbed oil must first be removed from the spent clay. G. de Salvo[12] proposes the re-activation of the spent clay by treating it with hot and diluted sulphuric acid, and mixing it with boiling water. After the clay is dried it is heated on a free hearth at a temperature of 300 deg. cent., and finally ground. Rosenbaum[13] treated spent clays with nitric, hydrochloric, acetic, and chromic acids, neutralizing the mixture with ammonia, after which it was dried.

Furthermore, the alkalies are able to re-activate the spent bleaching clay. The most simple method consists in treating the clay with an alkaline solution of water. This destroys the basic coloring matters and removes them from the interior of the microscopic channels. The operation is performed as follows: the spent clay free of adsorbed oil is mixed with alkali (5 percent of the weight of clay), and water is then added until a thin pulp results. This mixture is heated on a free fire or treated with direct steam. After a short time the solution becomes dark. The treating is continued until the darkening increases. The mixture is then pumped to the filter press and washed with water. The discharge liquid, that is, the dark-colored alkaline solution, contains all coloring matters and other adsorbed compounds. The remaining clay is dried, and is said to be again suitable for use in the adsorption process. Garstenberg[14] regenerates spent clays by first removing the adsorbed oil with volatile solvents, then washing the clay with an alkaline solution at a high temperature. Lowery[15] regenerated spent clay by washing it with a alkaline solution at a temperature of 80 to 90 deg. cent., after which he allowed the mixture to stand, then the clay was filtered from

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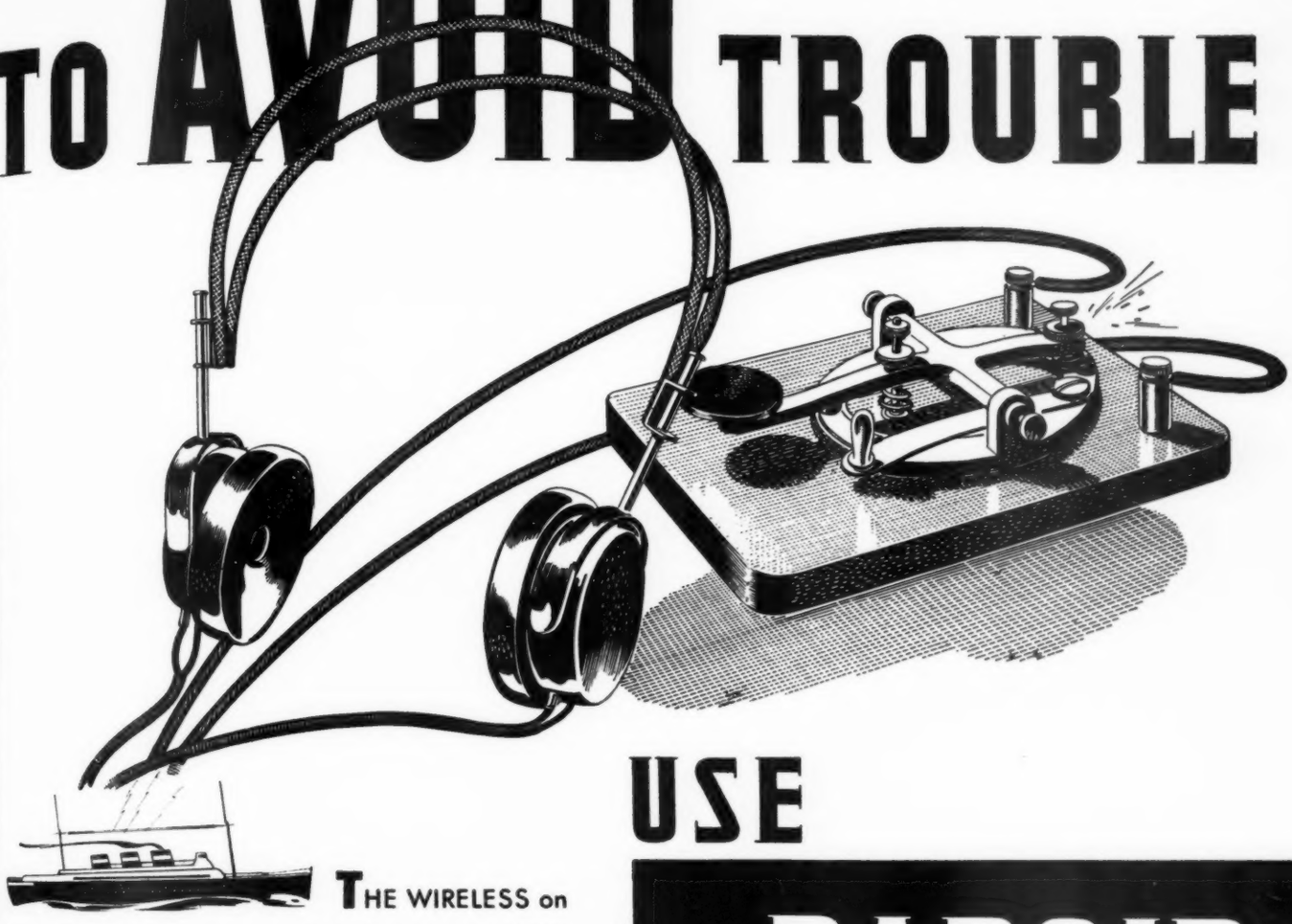

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the liquid, and the clay washed with water.

Let us now consider the reactivation of spent bleaching clay by means of the roasting process. There has been considerable discussion on the proper temperatures required. The impression should not be given that if the temperature curve varies slightly from suggested temperatures, given as a general guide, the clay will be ruined. A number of factors have to be considered in this connection. For example, the variation in the character of the several types of clay, the amount of volatile and carbonaceous matter in the clay fed to the furnace, and the method of taking temperature readings. To carry out the re-activation of spent clays by means of roasting, the organic compounds must first be removed from the interior structure of the clay. According to Singer the roasting of the spent clays must be done in the presence of air to cause the traces of organic compounds to oxidize and be removed as gases. In the absence of air these organic compounds are reduced to carbon particles, which are adsorbed by the microscopic channels, thus deteriorating the quality of the re-activated clay.

Of course, temperature plays a very important part. The U. S. Bureau of Mines recommends temperatures of 700 deg. fahr. for new Fuller's earth, 1000 deg. fahr. for first reburn, and 1050 deg. fahr. for all other burns. Experiments show that the rough surfaces of the Fuller's earth smooth over slightly at a temperature of 1300 deg. fahrenheit. The purpose of heat in the reactivating process is, first to dissipate moisture and volatile matter, which is present in limited quantities. This requires a temperature of about 600 deg. fahrenheit. Then comes the oxidation of the carbon.

Conditions favoring rapid oxidation are: temperature above the ignition temperature; continuous stirring to expose new surfaces to the oxidizing conditions; temperatures greater than 950 deg. fahr., to produce the flickering blue flames that indicate rapid oxidation is taking place, although carbon matter will burn out at a somewhat lower temperature. It is of great importance to assure a quick removal of the gases and vapors formed during the roasting of spent bleaching clay. Moreover, the volume of gases and vapors dissipated must be very small or the fine-grained clay particles also will be dissipated. This causes the clogging of the outlet orifice of the roasting furnaces, and the tarry distilling products cannot be decomposed.

The first consideration is always to prevent overheating. The temperature of the material as it enters the furnace will rise in endeavoring to reach the furnace temperature indicated on the pyrometer chart. Should the carbon content of the clay be so great that the heat rise is too great and rapid, the chart will record it immediately. When this excess temperature is reduced it is immediately recorded. Therefore, under all conditions pyrometers should be used to record gas temperatures. The recording should be on the hot side of the furnace, which means the safe side. This will record every change immediately and correctly. Contrast this with time lost in indicating a rise in temperature when the couple is imbedded deeply in the clay. Clay on the hearth oxidizes mostly on its surface. Suppose this surface for some reason gets too hot. Of course, the slow penetration of heat is finally indicated on the chart.

Viewing the re-activation process of the spent clays in the light of the above we are forced to the conclusion that the temperature and the proper amount of the air are the most important factors in this process. With this knowledge as basic factors many procedures have been patented, the most important being discussed briefly.

Ujhely[16] regenerates spent clays in a drum through which very hot air flows, causing the clay to glow in a retort of special construction. Hartley[17] proposes a procedure that permits spent clays to be re-activated continuously. The spent clay passes several hearths, in the meantime being stirred so that a large surface area is exposed to the oxidizing process. At the same time oxygen is directed counter-currently to the hearths. If thermocouples are inserted in the "cool" spots of the furnace, i.e., between the flue gas outlets and the burners, the temperature of the gases traveling away from the couples registering gas temperatures will be found to be a safe guide:

Hearth No. 1	500 deg. fahr.
Hearth No. 2	1000 deg. fahr.
Hearth No. 3	1000 deg. fahr.
Hearth No. 4	1100 deg. fahr.
Hearth No. 5	800 deg. fahr.
Hearth No. 6	600 deg. fahr.
Hearth No. 7	400 deg. fahr.
Clay outlet temperature	150 deg. fahr.

This latter temperature depends largely on the thoroughness of oxidation. Temperature of the completely oxidized clay will drop very rapidly, whereas clay still oxidizing as rabbled from the oxidizing zone likely will be so hot when discharged it will give trouble on the conveyor belts.

Sauer[18] elaborated on a method that regenerates spent clays by passing them through several retorts by means of a special mechanical apparatus. Here also air is allowed to pass countercurrently in the retorts. Furthermore, a very interesting procedure has been patented by the G. G. Brockway Company[19], Philadelphia. It is multiple-hearth furnace through which spent clay is directed. Its greatest advantage is the possibility of regulating the temperatures in the hearths. This advantage prevents the destruction of the bleaching clay.

The above-indicated temperatures relate to the natural bleaching clays; that is to say, to the Fuller's earths. Some artificially-activated bleaching clays suitable for decolorizing lubricating oils cannot be heated above 600 deg. fahr. without harming their efficiency. The reason for this is that the microscopic channels of these clays are so thin that the exceeding of these temperatures completely ruin the microscopic structure. Therefore attempts have been made to lower the temperature necessary to oxidize and destroy the impurities adsorbed on the clays by adding to the clays small amounts of certain catalysts, but thus far they have not been practicable. Lang, Anderson, and Fuchs[20] found that the metal catalysts at a given temperature lowered the amount of carbonaceous material in the clay but all of them, with the possible exception of cadmium and aluminium, impaired the decolorizing power of the clay.

Not all spent clays, however, recover their original activity. The reason for this is that not all clays have straight microscopic channels, and therefore the adsorbed impurities can not be removed from the interior microscopic structure. Even when these impurities are transformed to gases, a part will carbonize. Therefore, it is necessary to examine the bleaching clay before using it in the adsorption process. The reason for this is that the microscopic channels of such clays are closely chained. To remove the adsorbed impurities under such circumstances is quite impossible.

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NEW TEXAS BOILER LAW

Measure placed in effect in 1937 is expected to increase safety and lead to greater efficiency in boiler operation

By DENIS S. SNEIGR

ON August 1, 1937, the new Texas state boiler law went into effect and since that date approximately 10,000 boilers have been inspected and reported to the Boiler Inspection Division of the Texas Bureau of Labor Statistics.

Written and enacted primarily as a safety measure, this boiler law is expected to increase safety in boiler operation. It is aimed at remedying unsafe conditions in connection with oil field boilers as well as stationary power boilers, as can be seen by noting the exemptions. Under the law, the following boilers are exempt from the provisions of the act:

1. Boilers under Federal control and stationary boilers at round-houses and pumping stations of railway companies under the supervision and inspection of the superintendent of motive power of such railway companies;
2. Boilers in which the pressure does not exceed 15 lb. per sq. inch;
3. Automobile boilers and boilers on road motor vehicles;
4. Boilers used exclusively for agricultural purposes;
5. Boilers for heating buildings occupied solely for residence purposes and having accommodations for not more than four families;
6. Boilers used in cotton gins.

The stationary boilers covered by the law must be inspected internally and externally at least once each 12 months and the portable boilers, such as the boilers used on a drilling rig, must be inspected externally each time the boiler is moved to a new site and inspected internally each 12 months. The fees for inspecting a boiler are $10.00 for an internal and an external inspection, $7.50 for an internal inspection only, and $2.50 for an external inspection only.

No boilers may be installed in Texas unless they have been constructed according to the requirements of the Texas Boiler Construction Code; however, if a boiler bears the stamp of another state having standards equivalent to those of Texas, the boiler will be accepted for installation, or if the boiler complies with the requirements of the National Board of Boiler and Pressure Vessel Inspectors or of the American Society of Mechanical Engineers it will be accepted. Even after such boilers have been installed, however, they must stand an inspection by a Texas inspector.

If any second-hand boiler is installed, that is, if both the ownership and location are changed, the fittings and the appliances must comply with the Texas Boiler Construction Code for new installations.

Existing Installations

The greatest part of this new act concerns existing boiler installations. The first rule under this section sets the maximum allowable working pressure. The maximum allowable working pressure on the shell or drum of the boiler shall be determined by the strength of the weakest course, computed from the thickness of the plate, the tensile strength of the plate, the efficiency of the longitudinal joint, the inside diameter of the course, and the factor of safety allowed by the rules of the law. The law includes tables and formulas for determining the maximum allowable working pressure.

If the actual tensile strength of various materials is not known, the law provides that the tensile strength of steel shell plates be taken as 55,000 lb. per sq. in. and of wrought-iron shell plates as 45,000 lb. per sq. inch. If the actual tensile strength of cast iron is not known, it shall be taken as 18,000 lb. per sq. inch.

Welding Repairs

Considered important clauses in this new boiler law are rules 8 and 9, concerning welding repairs and their requirements. According to men familiar with boilers and their operation, faulty welding is responsible for a great number of boiler accidents. Rule 9, setting the requirements for boiler repairs by fusion welding, reads:

(a) A major repair by fusion welding, such as the repair or making of a new seam, the insertion of nozzles, or any repair involving the safety of a boiler shall be made in accordance with the section of the Texas Boiler Construction Code governing the particular kind of work to be done.

(b) No welding repairs shall be made before an inspection has been made by an authorized inspector and the method of repair sanctioned by him. If, in the opinion of the inspector, a hydrostatic test is necessary, such a test shall be applied when the work is completed.

(c) Fusion welding[1] on boilers will not be acceptable except in the cases specified herein where the safety of the boiler does not depend upon the strength of the weld.

(1) Fusion welds will be permitted on a staybolted surface or one adequately stayed by other means so that, should the weld fail, the parts would be held together by the stays.

(2) Cracks in girth seams extending from the edge of the plate to the rivet hole may be fusion welded. All cracks that may be welded shall be properly prepared to permit fusion through the entire thickness of the plate. Similar cracks in a longitudinal direction and located between the rivet holes may also be fusion welded, provided the cracks do not extend more than three in. beyond the edge of the lap of the inner plate. Cracks extending from rivet hole to rivet hole on girth seams shall not be welded.

(3) Calking edges of girth seams may be built up by fusion welding under the following conditions: The thickness of the original metal between rivet holes and calking edge to be built up shall be not less than one-fourth of the diameter of the rivet hole and the portion of the calking edge to be replaced shall not exceed 30 in. in length in a girthwise direction.

(4) Prior to making any repairs to girth seams by fusion welding the rivets shall be removed over the portions to be welded and for a distance of at least six in. beyond each such portion. After repairs are made the rivet holes shall be reamed before the rivets are redriven.

(5) When external corrosion has reduced the thickness of plate around handholes to an extent of not more than 40 percent of the original thickness, and for a distance not exceeding two in. from the edge of the hole, the plate may be built up by fusion welding.

(6) Stayed sheets that have corroded to a depth of not more than 40 percent of their original thickness may

[1]This comes under the heading of "Repairs by Welding." Paragraphs P-101 to P-114 of the Texas Boiler Construction Code give rules on fusion welding where the safety of the boiler depends on the strength of the weld.

HERE'S A TIP . . .

on truck-winch lines

MANY a superintendent has overlooked a bet on truck-winch lines that would save him money over the course of a year. We are referring to lines with independent wire-rope center instead of the usual hemp core.

There is a rather widespread impression that IWR-center lines are too stiff for the job. The fact is that stiffness or lack of flexibility has almost nothing to do with the way a rope stands up to a heavy pull over nine-inch sheaves. Life of a truck-winch line is determined by its resistance to crushing; the more nearly the rope holds its shape when bent sharply, the longer it will perform its job. Needless to say, any rope with a steel center will resist crushing far better than a similar rope with a fiber core.

As for price, consider this: IWRC Line costs only 15 per cent more than the same quality of hemp-centered line. Having additional steel in it, it has considerably more strength. If it lasted only 15 per cent longer, it would be well worth while. As a matter of fact, most users find it lasts much longer.

Almost without exception, the highest grade line—Purple Strand with independent wire-rope center—is the most economical for truck-winches. Specify it when next you buy such line.

BETHLEHEM STEEL COMPANY, *General Offices:* Bethlehem, Pa. *District Offices:* Albany, Atlanta, Baltimore, Boston, Buffalo, Chicago, Cincinnati, Cleveland, Columbus, Dallas, Detroit, Honolulu, Houston, Indianapolis, Johnstown, Pa., Kansas City, Mo., Los Angeles, Milwaukee, Nashville, New Haven, New York, Philadelphia, Pittsburgh, Portland, Ore., St. Louis, St. Paul, Salt Lake City, San Antonio, San Francisco, Savannah, Seattle, Syracuse, Toledo, Tulsa, Washington, Wilkes-Barre, York.
Export Distributor: Bethlehem Steel Export Corporation, New York.

BETHLEHEM STEEL COMPANY

be reinforced or built up by fusion welding. In such cases the stays and staybolts shall come completely through the reinforcing metal and the original ends of the staybolts shall be plainly visible to the inspector. When necessary to replace stays and staybolts, they shall comply with the requirements of the Texas Boiler Construction Code.

(7) In fire-tube boilers where tubes enter flat surfaces and the tube sheets have been corroded or where cracks exist in the ligaments, fusion welding may be used to reinforce or repair such defects. The ends of such tubes may be fusion welded to the tube sheets after they have been rolled and beaded. A locomotive-type boiler that has been repaired by renewing the entire tube section of the firebox tube sheet or of the cylindrical tube sheet by using a corner fusion weld to attach the new plate to the inner surface of the old head flange may be continued in service provided: the appearance of the weld is satisfactory to the inspector, none of the tubes have been safe-ended and the new section is of equal thickness to the plates removed and has a bearing at the head flange equivalent to the thickness of the plate. When tube renewal becomes necessary a new section, of such repaired tube sheet, having a head flange and a riveted seam shall be installed. Such repairs for tube sheets and the welding in of tubes in the sheets shall not be permitted where such sheets form the shell or drum of a water tube boiler.

(8) Unreinforced openings in the shells or drums of boilers or pressure vessels, provided they do not exceed in diameter the size of unreinforced openings permitted by the Texas Boiler Construction Code (Par. P-268a Revised) may be closed by the use of a patch or plate, at least two in. larger in diameter than the hole, placed on the inside of the drum or shell and sealed against leakage by fusion welding, preferably on both the inside and outside edges. Such patches shall not be set in the shell flush with the surrounding plate.

(9) The repairing of tubes or headers in water-tube boilers by fusion welding is not permitted.

(10) Cracks in the shells or drums of power boilers except as otherwise specified herein, shall not be welded.

Hydrostatic tests shall be applied to the boiler upon the completion of attachment of either welded or riveted patches.

The building-up of grooved or corroded areas of unstayed internal surfaces, other than widely scattered pitholes, by means of deposited metal is not approved.

Leakage at riveted joints or connections must be carefully investigated to determine the cause of such leakage before attempting any repair.

Another important rule of the boiler law is Rule 13, which deals with tube ends. Rule 13 reads as follows:

(a) A fire-tube boiler shall have the ends of the tubes firmly rolled and beaded, or rolled, beaded, and welded around the edge of the bead. Where the tubes do not exceed 1½ in. in diameter, the tube sheet may be chamfered or recessed to a depth at least equal to the thickness of the tubes and the tubes rolled into place and welded.

(b) The safe-ending or re-tipping of tubes in water-tube boilers is prohibited. The reinstallation of used or second-hand tubes in water-tube boilers is prohibited; unless, in the opinion of the inspector of steam boilers, deputy inspector, or authorized inspector, the condition of the tubes will warrant reinstallation.

(c) Ends of such tubes shall be properly annealed for expanding and flaring and shall pass through the tube holes at right angles with the tube sheet, or if the tubes be of the bent type tube they shall enter the tube holes at right angles to a tangent to the circumference drawn at the tube hole, and shall have a straight section at least equal to one-half tube diameter outside of shell.

(d) Tubes of fire-tube boilers may be safe-ended or re-ended by the forging process of welding. Tubes of such boilers may also be safe-ended or pieced by the fusion-welding process provided such tubes are well distributed and their number does not exceed 50 percent of the total, and further that there is not more than one circumferential weld in any one tube, the maximum length of the tip being 24 in., or that there are not more than two circumferential welds in any one tube, the maximum length of any one tip not to exceed 12 inches.

Where more than 50 percent safe-ended fusion welded tubes are found in a boiler, they may be allowed to remain, provided the present welded tubes are approved by inspector of steam boilers, deputy inspector, or an authorized inspector. Before an inspector can grant his approval, three or more tubes will have to be removed and the welds tested for soundness and ductility. Samples shall be cut from the welds into longitudinal strips of 1 in. in width and about 3 in. in length, and any reinforcement ground off and the specimen broken at the weld. This method of examination may be accomplished by gripping the specimen at the weld in a vise, and the extended section driven backward with a hammer, so that the weld will be opened at the root. To be satisfactory, welds broken in this manner shall be clean and properly fused through at least 90 percent of the thickness of the tube.

For the possible installation of more than 50 percent safe-ended tubes, the inspector may test the soundness and ductility of the welding procedure for safe-ended tubes to be placed in a fire-tube boiler by selecting at random three or more tubes of the set so welded before installation and by cutting samples and testing such samples as outlined in the preceding paragraph.

For the possible installation of more than 50 percent safe-ended tubes in a fire-tube boiler, the inspector may test the soundness and ductility of the welding procedure having the welding operator make several sample welds between two pieces of boiler tubing, the welding to be done under the same conditions and by the same process as will be the case in the actual safe-ending of the tubes. The procedure for testing such samples is outlined in the preceding paragraph.

Two other important rules deal with the reporting of accidents and the attendance of boilers. In case of an accident to a boiler that disrupts the service of the boiler, the owner must make a detailed report to the Boiler Inspection Division of the Bureau of Labor Statistics. If the accident is serious, such as an explosion, the operator or owner of the boiler must notify the Bureau immediately by telegraph and nothing at the scene of the accident, either the boiler or its parts, may be removed or disturbed until the scene is visited and inspected by an inspector from the Bureau.

The rule dealing with attendance on boilers states that a boiler in active service can not be left unattended for a period longer than 20 minutes. This rule holds true whether or not the boiler in question is fitted with automatic devices such as automatic feedwater regulator or high and low water alarm.

Other rules in the law cover safety valves, gauges, fusible plugs, and in fact every connection and device found on a steam boiler. Section IV of the Rules gives detailed instructions as to the method of inspection and preparation for inspection.

This law was enacted as a safety measure and, although there are objections from some operators because of the necessity of replacing wornout and antiquated boilers, in the long run this act will prove valuable both to the operators and to the workmen in the field.

Piston and connecting rod assembly

By
OTTO
NONNENBRUCH
De La Vergne Engine
Company

Connecting Rod Bolts in Diesel Engines

An understanding of the stress conditions under which bolts work is essential to correct maintenance

CONNECTING rod bolts are essential elements in the construction of reciprocating machines, such as the typical Diesel engine. The stress conditions under which these bolts work are often misunderstood, although a proper appreciation is particularly helpful in the correct maintenance of these parts.

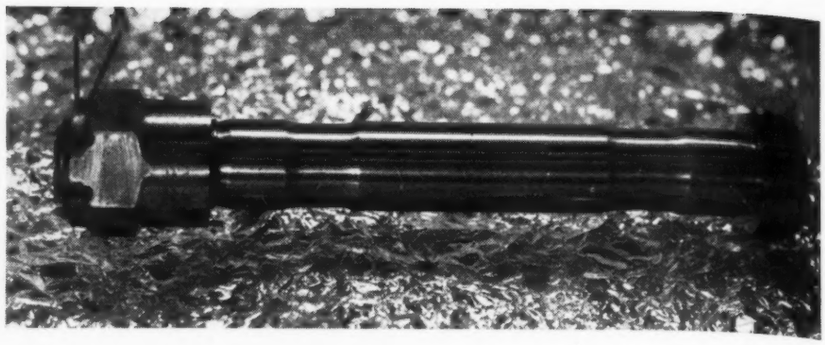
First, let us consider an assembled connecting rod bearing with the crankpin bearing bolts in place, but not tightened. Assume there are two bolts, one on each side of the bearing. If the bolts are tightened alternately and evenly, it will be observed that the length of the bolts will increase slightly and that the bearing parts will be compressed slightly. If, after only reasonable tightening, the bolt nuts are loosened, it will be found that the bolts and bearing box parts have returned to the same dimensions as before tightening. This indicates that the stresses set up by the tightening process were below the elastic limits of the materials of the bolts and the bearing parts.

Assume now that the bolts are tightened again, this time using a sledge hammer with unreasonable force, until the overall length of the bolts is increased excessively. When the bolt nuts are loosened and the parts again measured, it will be discovered that the overall lengths of the bolts are now greater than the original dimensions. This indicates that the stresses set up by the tightening procedure have exceeded the elastic limit of the material and the bolts have been damaged and cannot safely be used again. It will be observed that this damage has occurred under conditions where the engine is not in operation. This leads to our first important conclusion: a connecting rod bolt may be ruined simply by improper tightening procedure.

The next consideration is to visualize the nature of the stresses introduced during actual operation. Picture the bearing previously discussed, properly assembled in a running engine. Assume a vertical, single-acting, 4-cycle engine, and follow the varying conditions of load and stress occurring during the working cycle, starting observations at the firing dead center. At that time, the gas pressure in the cylinder is about the maximum of the cycle and this pressure forces the upper half of the connecting rod bearing against the crankpin. The stresses in the connecting rod bolts under these conditions are very little different from those imposed in assembly. As the piston moves downward toward lower dead center, all factors are such as to maintain pressure between the upper bearing half and the crankpin, and no important stress changes are introduced in the bolts. This continues during the first part of the next or exhaust stroke when the crankpin is forcing the piston upward, accelerating the reciprocating masses. A change occurs in the latter part of this stroke, when the momentum of the reciprocating masses, meeting practically no resisting gas pressure in the cylinder, causes the assembly of piston and connecting rod to pull on the crankpin. The stress in the connecting rod then reverses from compression to tension. The pull of the piston and connecting rod must be taken by the connecting rod bolts. This condition continues during part of the next, or suction stroke, until the stress in the connecting rod reverses from tension to compression as the momentum of the reciprocating masses acts downward. During the final, or compression stroke, the connecting rod remains in compression because of increasing air pressure in the cylinder. Condensing the result of these observations, it can be said that the tension load in the connecting rod bolts does not change materially from that produced by the original assembly, except during a small part of the cycle when the connecting rod is in tension. At that time there is additional tension in the bolts.

Next, consider the stress conditions in the complete crankpin bearing assembly as the result of these loads. Pressure of the bolt head and nut contact areas causes compression in the surrounding material of the bearing halves. When the connecting rod is unstressed or in compression, the tension load in the bolts equals the compression load in the bearing box material. Tension loading of the connecting rod alters this equilibrium, by introducing additional tension in the bolts, which in turn reduces the compression in the bearing box material. The additional load in the bolts is less than the tension load in the connecting rod by the amount the bearing box compression is relieved. It is important to appreciate this fundamental condition, which

A bolt 12⅞ in. long, 1-9/16 in. in diameter, for an engine of 12½-in. cylinder bore



is illustrated by the following example: assume that the initial tension load applied at assembly in each of two bolts is 50,000 pounds. Assume also that the bolts and box parts are equally elastic, which means that for each pound of tension load increase in the bolts there will be one pound reduction in compression load in the bearing box material. Now, if the inertia forces introduce a tension load of 20,000 lb. in the connecting rod, or 10,000 lb. for each side of the bearing box assembly, the reactions will result in an increase in tension load in each bolt of 5000 lb. and a reduction in compression load of the bearing material surrounding each bolt of 5000 pounds.

This example illustrates actual conditions in a general way. The figures used are arbitrary, but the fact that the bolt tension load increases only a fraction of the amount of the tension in the connecting rod applies in all cases. It is therefore an error to imagine violent fluctuations of stress in connecting rod bolts as a result of the inertia forces. In the above example the total load per bolt ranged from an initial load, due to assembly, of 50,000 lb. to a maximum of 55,000 pounds. In actual practice the bearing box is usually less elastic than the bolts, with the result that the bolts take considerably less than half the tension load of the inertia forces. Generalizing, it will be evident that the stiffer the bearing construction and the more elastic the bolt, the smaller will be the change in bolt tension introduced by the inertia forces.

Now let us consider certain complications. First, visualize that the entire bearing and bolt assembly is made of elastic materials. When the bolts are tightened, in addition to effects introduced by pure tension, there are also effects introduced as a result of actual twisting of the bolt during the tightening. The face of the bolt head in contact with the bearing box material may not be exactly square to the center line of the bolt under loaded conditions. Such misalignment can be caused by irregular elastic deformations in the bearing box material under the pressure of the bolt head. This same condition may also occur at the nut end and these effects may be aggravated by improper mechanical fit. There may also be conditions in which the bearing, as it compresses, deforms in an irregular manner such as actually to bend the bolts. In other words, as the bolts are tightened, complex stress conditions resulting from unavoidable deformations of the entire bearing assembly are introduced. These introduce factors that are indeterminate mathematically but nevertheless constitute very real stress conditions. Proper assembly practice and proper operating conditions, including proper running clearances, will materially reduce such indeterminate stresses. It must be appreciated that the indeterminate stresses may under certain conditions be more consequential than the determinate stresses, and calculations based on tension only may therefore, under such conditions, be misleading.

It is now in order to review some of the considerations involved in the design of connecting rod bolts. In a proper design the stresses applied at any time and in any part of the bolt must be well below the elastic limit of the material of which the bolt is made. On the other hand, the bolt must be fitted into a space limited by other design considerations. The design of the bolt must provide maximum safety and still conform to the space limitations. Materials used for construction of bolts should be suitable heat-treated alloy steels. Manufacturers must employ exacting procedure in the procurement of bolt material, control of heat treatment, and machining, and must exercise rigid inspection and testing. The extreme care with which manufacturers construct connecting rod bolts is not generally appreciated. Too much emphasis cannot be laid upon the importance of obtaining all such bolts from the manufacturer.

The technique of mechanical assembly plays a very important part in proper performance of a connecting rod bolt. Heretofore, the manufacturer, through written or verbal instructions, has prescribed methods of bolt tightening that have been based largely on mechanical feeling or judgment to be exercised by the operator in establishing the proper tightness. In most cases, recommendation has been made that so much man power at the end of a lever of a given length should be employed. Wrenches equipped with shear pins have been provided. Supplementary precautions have also been generally adopted, such as marking the bolts and nuts in sets and maintaining the same pairing, and inspection of the seats for squareness, foreign particles, or damage.

It has been recommended that the length of the bolts should be checked accurately at each overhaul and if a bolt shows any permanent elongation, however small, it must not be used again. Most careful inspection should also be made of the surface of the entire bolt, including threaded section, for evidence of hair-line cracks invisible to the naked eye, stress-raising nicks, and similar defects, any of which render the bolt unsuitable for further use. The original carefully finished surface of the bolt should not be altered by filing or any ordinary machining work. No attempt should ever be made to straighten a bolt either in a cold or heated condition, and under no circumstances should a bolt be annealed. All these precautions, however, are only a partial protection, because fatigue failures occur with practically no preceding deformation of the material, and incipient cracks are not readily discovered in spite of the great progress that has been made in this direction. It is therefore good practice to replace the bolts at suitable intervals as a precaution, even though no defects are evident. The manufacturers' recommendations as to such intervals, expressed in hours of engine service or revolutions, should be carefully followed.

Let us return now to the all-important question of how much to tighten the bolts. A proper procedure can be built around an increase in length by a definite amount. The proper increase in length of the bolt when correctly tightened can be determined for each specific engine by calculation, tests, and experience. A measuring device and procedure can then be used that are readily applied and at the same time accurate. Different manufacturers' advice in this respect may vary, but the method is now widely accepted and eliminates the dangerous uncertainty regarding the degree to which the bolts should be tightened in assembling.

Efficiency of Gasoline Plant Operation Increased by Refrigeration of Absorption Oil

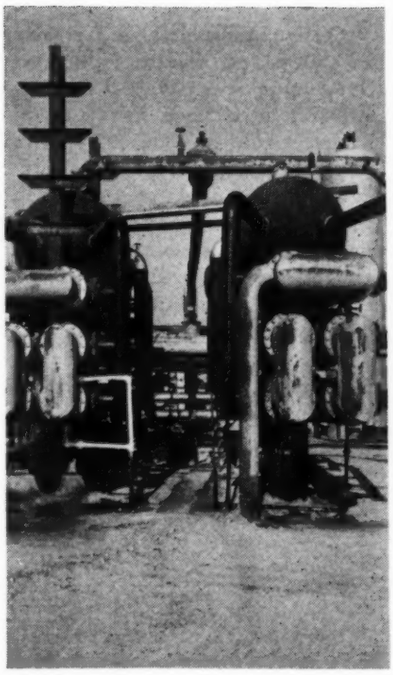
Mixture of propane and butane obtained from stabilizer overhead is economical refrigerant

By J. C. ALBRIGHT

WITHOUT installing expensive fractionating equipment to produce sharply defined hydrocarbons for refrigeration of absorption oil, J. E. Crosbie, Inc., has increased the efficiency of the Fitts gasoline plant approximately 20 percent by using condensed stabilizer overhead discard, which is a "run of the mill" mixture of propane and butane. Equipment utilized in refrigeration consists of heat exchangers, arranged in three sections, 3-cylinder, 13½-in. by 20-in. compressors, and condensing units to liquify the refrigerant.

Experiments have been performed in the Fitts plant for several months to determine what kind of equipment could be used to cool the absorption oil sufficiently without necessitating rebuilding the plant or purchasing extra equipment. The equipment finally installed processes about 3,000,000 cu. ft. of propane and butane vapors per day, continuously recycled within a closed system, and reduces the temperature of absorption oil from about 95 deg. fahr. on the outlet from the atmospheric coolers to about 60 deg. fahr. on the inlet to the absorbers.

Refrigerant is made in the plant from condensate from the stabilizer overhead, and varies in composition according to the grade of natural gasoline withdrawn from the reboiler. When 26-lb. natural gasoline is being made, the refrigerant is principally propane, as the characteristics of gas from the Fitts pool make it extremely difficult to produce regular 26/70 gasoline when all the butanes are removed from the bottom product in the stabilizer. An analysis of the field gas is as follows:



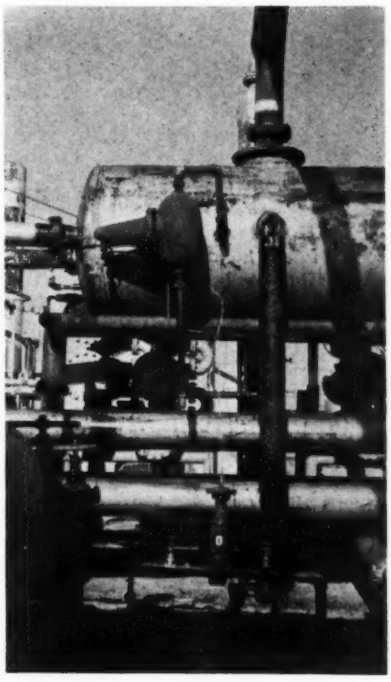
Primary double unit for refrigeration of absorption oil. The split stream flows through two units for extraction of high heat, subsequently passing through an additional system to reduce to 60 deg. fahr. the temperature of the oil going to the absorbers

	Percent	*Gal. per M.*
Methane	78.84	
Ethane	10.96	
Propane	6.32	
Iso-butane	0.93	.303
N-butane	1.52	.479
Pentane plus	1.43	.586
Total	100.00	1.368

The primary equipment for refrigeration consists of two units. One is constructed from six sections of 12-in. heat exchangers and has a total exchanger surface of 2808 sq. feet. A 4-ft. by 9-ft. vessel is mounted above to maintain the fluid level of the refrigerant. The other unit has six sections of 10-in. exchangers, containing a total exchanger surface of 1890 sq. ft., and is also equipped with a 4-ft. by 9-ft. vessel mounted above. Only one liquid level controller is used on the units, as that is sufficient to maintain the required liquid level of refrigerant in both drums.

The secondary system is made of four 10-in. sections, and 12 10-in. by 5-ft. smaller units, having a total exchanger surface of 1962 sq. feet. This system also contains a 4-ft. by 9-ft. vessel mounted in the same manner as those above the primary units, and a liquid level controller operating by remote control the valve that admits the refrigerant to the system.

The absorbent leaves the atmospheric coolers through a single line that leads to the primary refrigeration units, where it branches to split the



A part of the refrigeration system used to reduce the temperature of absorption oil for more efficient extraction of gasoline

stream so each unit will cool an equal volume of oil, removing the high heat from the material. Each outlet is joined to a single line, leading to the secondary refrigerator, where the temperature is lowered to that required for operation.

The system, filled with the mixture of propane and butane, is maintained at a pressure of about 125 lb. on the discharge of the vapor compressors, and this pressure is carried at the control valves. These valves are installed in small lines, the same diameter continuing throughout the distribution system to several points below the exchangers, where the lines are enlarged to 2-in. pipe connections on the shells of the lower sections of exchangers. Fluid is maintained at a level approximately half way up the horizontal vessels, and outlet pressure varies from atmospheric to about 5 lb. gauge. Piping 4 in. in diameter is attached to the outlet on the cooling side of each exchanger section to permit flow of liquid and vapors from each unit to the vessel above without restriction or excessive back-pressure.

Oil is circulated at an average rate of 650 gal. per minute, approximately 936,000 gal. per day, and under normal atmospheric conditions is cooled to a temperature of about 95 deg. fahr. in the atmospheric sections in the louver tower. After the oil flows through the two primary refrigeration units and the secondary system, its temperature is lowered to approximately 60 deg. fahrenheit. Temperature reduction in this unit is not obtained directly by expansion of the refrigerant into the exchangers, but by constant evaporation of the liquid, because of the reduced pressure within the liquid drums above the units and the higher temperature of the absorption oil entering the system.

Material used to build the refrigeration unit was obtained from plants that have been dismantled in fields no longer requiring gasoline plants. This accounts for the difference in size and capacity of the several banks of exchangers installed. Before being assembled all exchanger units were reconditioned.

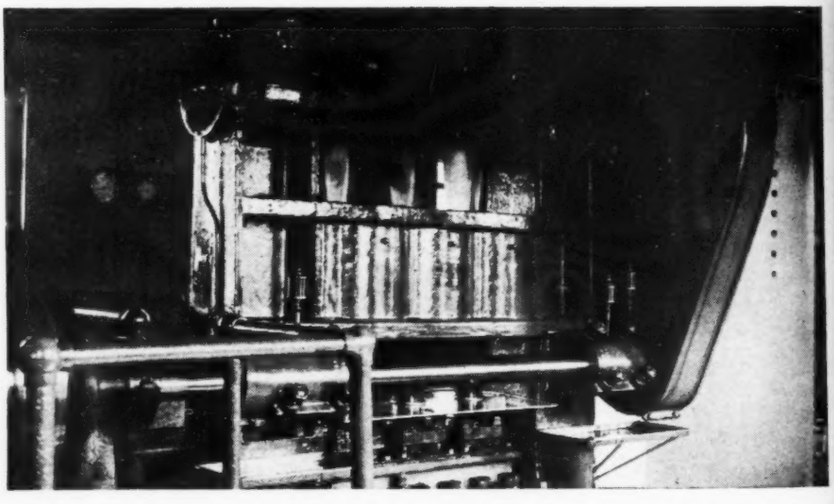
Under normal plant operation the refrigerant contains a variable amount of both propane and butanes, and the system is recharged at intervals of about three months to remove heavier fractions remaining after normal evaporation has eliminated some of the lighter fractions. When this procedure is followed the liquid is trapped from the refrigeration system accumulator drum directly into the plant stream of gasoline and refractionated to recover both the lighter cuts and the heavier fractions that may be used for making regular grades of gasoline.

In order to determine the efficiency of the refrigeration system, it has been shut down at intervals when the plant was processing a normal load of field gas. Before taking the cooling units out of service in these tests, plant production was considered to be 100 percent, for convenience in computation, but for periods when normal atmospheric cooling was obtained without refrigeration, production declined to approximately 80 percent with no other changes in operation, or apparent changes in plant load or quality of gas delivered from the field.

Oil Drip Pans on Water-Pumping Machinery

IN the water-flooding area around Bradford, Pennsylvania, South Penn Oil Company operates several plants equipped with high-pressure pumps, many of which are vertical, triplex units driven by multicylinder gas engines. These pumps are direct-connected to the engines, so the lay shaft to the reduction gears has two exposed bearings, which are lubricated with sight-feed oilers.

Under normal operating conditions, these bearings receive more oil than is consumed. The surplus flows from the mounting, and if not directed elsewhere will drip on the base of the pumps or on the concrete floor. Under each bearing has been placed a catch basin, made of light sheet metal in the form of a shallow pan, which is attached to the base of the pump by brackets and studs.

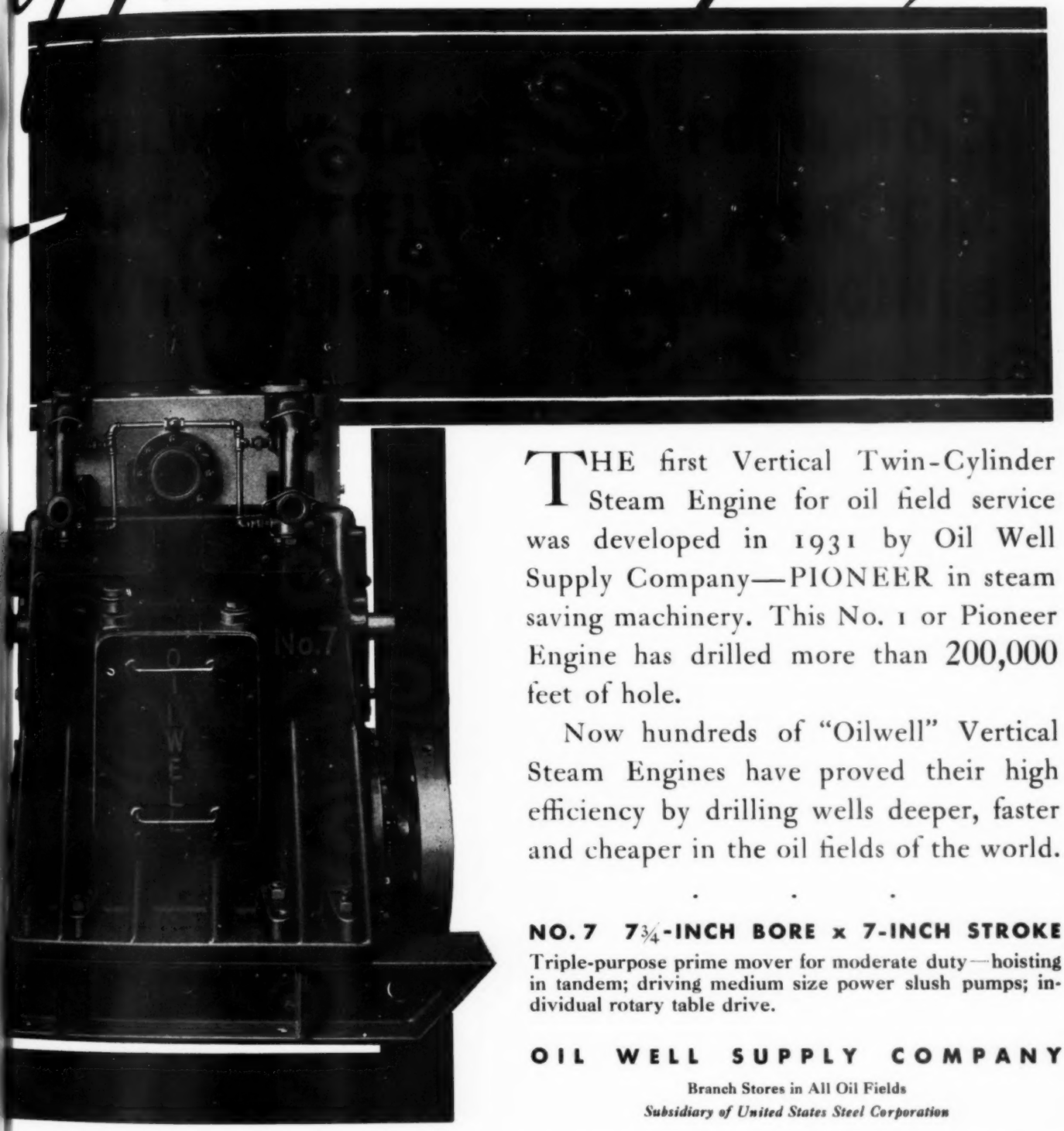


Drip pans placed on high-pressure water pumps used by South Penn Oil Company on water-flooding properties at Bradford, Pennsylvania. Pans are built with reservoirs so oil will flow from pan without becoming filled with dust

To one end of each pan is welded a reservoir, in the form of a can having a capacity of a pint of liquid. The pans are attached in such a way that the oil will flow to the reservoir, which can be emptied by removing a ¼-in. cast-iron plug screwed into a collar attached to the lower end of the reservoir.

An extremely shallow pan is attached to the pump between the crosshead and the packing gland of the piston to catch what oil may drip from above, and to direct it through tilted corners to the catch basins on the base. These inexpensive, easily-installed devices add greatly to the appearance of the pump room by preventing oil from staining equipment and floors.

# of Pioneering



THE first Vertical Twin-Cylinder Steam Engine for oil field service was developed in 1931 by Oil Well Supply Company—PIONEER in steam saving machinery. This No. 1 or Pioneer Engine has drilled more than 200,000 feet of hole.

Now hundreds of "Oilwell" Vertical Steam Engines have proved their high efficiency by drilling wells deeper, faster and cheaper in the oil fields of the world.

. . .

NO. 7 7¾-INCH BORE x 7-INCH STROKE

Triple-purpose prime mover for moderate duty—hoisting in tandem; driving medium size power slush pumps; individual rotary table drive.

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Fig. 1. Pipe-line crew carefully coating a river weight

By
DAVE HARRELL

Corrosion Engineer,
Houston Pipe Line Company

Pipe Line Coatings and Cathodic Protection

Many factors affect the choice of coating and type of unit for cathodic protection

IT has become general practice among oil and gas pipe-line companies to coat all pipe lines before laying them in the ground. These coatings range from cold grease to expensive pitch enamels. Every day someone asks us which is the best coating to apply to a piece of pipe and we always reply that the best coating is that coating which possesses the highest electrical resistance per sq. ft. after it is laid in the ground and which is able to maintain this high electrical resistance over a long period of time.

With the increased popularity of cathodic protection and its general use in the Gulf Coast area we found that we had another set of questions asked us: how much current does it take to protect a pipe line and shall we attempt to protect practically bare lines or shall we dig up the old lines and coat them and then apply our cathodic protection? About all we can say in reply to these questions is to set out as many of the determining facts as possible where everyone can see them and let each pick a set of circumstances that seems to fit his particular conditions and find his own answer.

The electrical unit of the current, the international ampere, has been defined as that amount of current that will deposit .00111800 grams of silver per second from a solution of silver nitrate[1]. This electroplating process is nothing more than accelerated galvanic corrosion of one metal surface at the expense of the other. We find that it functions by reason of current electricity and we also have found that both corrosion and its man-made antithesis, cathodic protection, depend for their progression on the flow of electric current. Static electricity apparently does not promote or retard electro-chemical activity. Corrosion of underground pipe lines was soon identified as the chemical disintegration of the iron they contain. This chemical transfer was accomplished in a solution of ionized salts and accompanied by the generation of electric currents that were caused to flow from one electrode to the other because of a difference of electrical potential. This difference of potential was always of sufficient magnitude to overcome the soil resistance that corresponds to the internal resistance of a voltaic cell.

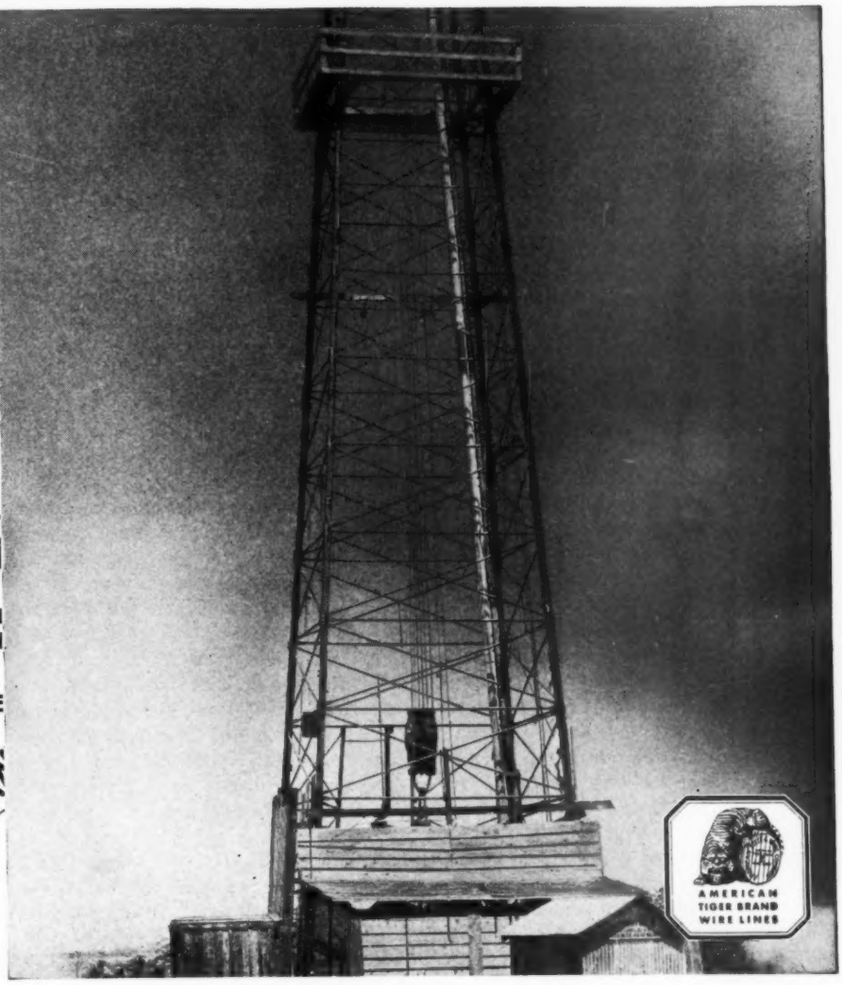
It was soon found that these differences of potential, which indicated current flow, were of two forms; they were either induced from some outside source such as stray currents from street railway lines, or they were galvanic and had their origin in the pipe-line soil itself. In the first case, it is always propitious to set up a system of electrical drainage and relieve the pipe lines of the current they are carrying by conducting it back to the source through a network of low-resistance conductors. In the second instance, an artificial set of circumstances can be created to overcome the weak potentials so set up and we call this cathodic protection, as it always involves making the pipe line highly cathodic to an anode buried at some distance from it.

Galvanic currents on pipe lines are of three distinct kinds: (1) The long line currents that accumulate over long sections of welded or coupled lines and discharge in sections surrounded by low-resistance soil; (2) the currents that always flow through the soil around an insulated joint or sleeve in the pipe line; and (3) the local action galvanic currents that set up small differences of potential in areas no larger than a dime on the surface of a piece of pipe.

We combat all three forms of corrosion by first bonding the insulating joints, if there be such, with heavy copper wire and then reversing the flow of current so that it flows from a remote anode to the pipe through the soil in which the pipe lies. We increase the current flowing in this artificial

[1]Handbook of Chemistry and Physics.

This wire rope is the TOUGHEST on the job!



AMERICAN Tiger Brand Wire Lines are tough. They are strong, and yet elastic enough to withstand the sudden shocks of drilling. They are flexible. They handle easily. They are safe and economical to use. Their uniformly high quality saves you money by reducing the danger of delays due to breakage.

The ability of American Tiger Brand Wire Lines to stand up under heavy punishment is provided for in the specifications to which they are precisely made . . . guaranteed by the care with which they are produced by experienced men in our plants . . . proved by their efficient and economical use in the field.

Engineering progress has made possible such a wide range of types, sizes, and grades that there is a correct wire line for each job. American Tiger Brand Wire Lines are available in Standard (non-preformed) or Excellay (preformed) constructions. Our engineers can help you determine which wire lines are the most practicable and most economical for your requirements.

American TIGER BRAND Wire Lines

AMERICAN STEEL & WIRE COMPANY

Cleveland, Chicago and New York

COLUMBIA STEEL COMPANY, Russ Building, San Francisco

United States Steel Products Company, New York, *Export Distributors*

UNITED STATES STEEL

circuit until the measured voltage drop from soil to pipe is a minimum of minus .24 volt. The reason we have chosen this minimum is that laboratory tests seem to indicate that all local action currents cease at this point and that the iron in our pipe line is not taken into solution in any of the soils we have encountered. Also, we have never found a soil in which the sustained iron-to-iron potential exceeded minus .24 volt. As we associate all galvanic corrosion with its manifestation of potential we assume that when we have attained an absolute voltage drop from soil to pipe of minus .24 volt we have successfully averted any further galvanic currents from natural sources. We measure this soil-to-pipe drop either with an ionic balance employing copper sulphate electrodes and an extremely high resistance meter or by vacuum-tube voltmeters and iron or steel contactors made from the pipe itself. In either case the current drawn must be below that necessary to cause polarization either between the copper contactors of the copper sulphate electrodes or the iron ones of the vacuum-tube arrangement.

How much current do we have to feed from our anode to obtain this minimum negative protective potential on the pipe? This obviously depends on many factors. First, it depends on the area exposed and specific resistance of the substance from which our anode is constructed. Secondly, it depends on the sq. ft. area of the pipe in the section on which cathodic protection is desired. Third, the ohms per cu. cm. resistivity of the soil through which the current is passing. Fourth, the resistance of the feed wires, pipe, and internal resistance of the current generator used. Lastly, it depends on the condition of the coating on the pipe on which protection is desired. This last factor is related to the second one as the area involved will depend on how much pipe is effectively covered by the coating.

This last factor is the one most important of all because it will most vitally affect the amount of current necessary to provide cathodic protection. The materials used to coat pipe lines are all of sufficiently high specific resistance that no current would be drawn at the low voltages commonly employed in electrically protecting pipe lines if a perfect job could be obtained. The amount of current drawn then at customary low voltage is in turn a measure of the worth of the coating job when compared to the amount of current necessary to protect bare line of a similar area.

This company has in operation a section of 5600 ft. of coated 18-in. line that is adequately protected by a current of six amp. at six volts. This gives a current of .000257 amp. per sq. foot. On the other hand, we have a similar section where the coating is in such bad condition that the best we have been able to do is .00452 amp. per sq. ft., or about 20 times the current necessary. This picture looks bad enough, but when we consider the power required we find that the almost bare pipe takes 113 times the power in watts per sq. ft. required by the well-coated section. The superintendent of another company told the writer that he was able to protect 40 miles of 8-in. line with 40 amp. when the line was well coated and lying in a high resistance soil. This is the best we have ever heard of and yields a factor of .000083 amp. per sq. ft. and approaches a perfect coating job.

As coating plays such an important part in the reduction of exposed pipe area and consequently the amount of current and power necessary to protect a pipe line cathodically, we have given the application of pipe coatings our special attention for the last several years. On page 97 of the October, 1936, issue of *The Petroleum Engineer*, the writer described the type of holiday detector used to find holes in pitch enamel coatings and in the Mid-Year, 1937, issue of *The Petroleum Engineer* there was described in detail all the operations performed in applying pitch enamels to large-diameter pipe lines. Since that time we have further perfected our holiday detector so that it now delivers some 20,000 volts and draws but two amp. from an 8-volt dry battery. Finding holidays is important in obtaining good coating jobs and we have found that it is necessary that the spark used be capable of jumping an inch in dry air. The following table from the Smithsonian Institute gives the voltage necessary to jump various distances in dry air between point electrodes.

Decimal of inch	*Voltage*
.1	3720
.2	4680
.3	5310
.4	5970
.5	6300
.6	6840
.7	7455
.8	8070
1.0	8670

Model "T" Ford spark coils were in general use in most of the early holiday detectors and they were better than no holiday detector at all, but they drew heavily on the primary source of current, which usually is a storage battery that is hard to transport along a line being laid. With the arrival of high-compression motors in automobiles it was necessary for car manufacturers to raise the voltage of the jump spark coils placed on them. We find that it takes 12,000 volts to jump a .02-in. gap at 80-lb. pressure[2]. By using a coil from a modern high-compression automobile and the vibrator unit from the radio on the same car we have been able to make a holiday detector that will not only find voids but puncture thin places in coatings as well. The result is that although we fixed twice as many holidays as before, our per sq. ft. resistance for coated lines has more than doubled.

Fig. 1 shows a pipe-line crew carefully coating a river weight before allowing it to settle slowly into place. This was done not so much to protect the weight from corrosion as to cut down on the exposed area of metal in the crossing line and in this way reduce to a minimum the expense of applying cathodic protection to the crossing.

As to the type of coating to use, we have the following observations to record. Pitch enamels of high melting point are rather brittle and we have never been able to obtain a good job

[2]Gas and Oil Engines by Marks, p. 197.

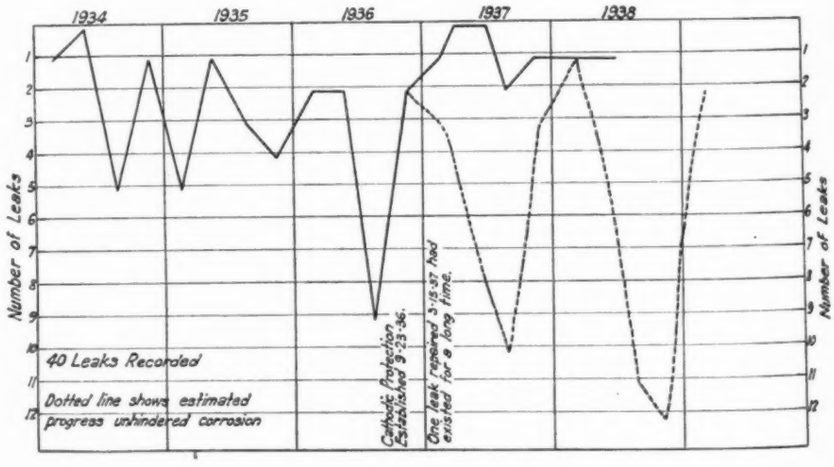


Fig. 2. Leak frequency curve on a mile section of 16-in. pipe

with them on small-diameter pipe. Much better success is had when they are fluxed down to 165- to 170-deg. melting point for application to lines of smaller than 6-in. diameter. We feel that a good durable shockproof wrapper should be used with these more ductile coatings. The high-power holiday detector can be run over the wrapper and will find holidays by jumping right through it to the bare pipe underneath. We do not recommend this procedure, however, unless the weather is so hot that the softer coating will not set up hard enough to permit the detector to run directly over it. For temporary small-diameter lines and leak repairs on large-diameter lines we use the asphalt and grease coating, as described in an article that appeared in *The Petroleum Engineer* for September, 1936, on page 50. As cited in this article, the grease seals the asphalt and the asphalt holds the grease. The holiday detector may be run over the paper wrapper as described above.

The principal factor that should determine the coating to be used would appear to us to be an economic one. The oil and gas transportation industry is shot through with temporary expenditures for gathering systems, etc. On such lines as these where their effective life is not more than three or four years, it would seem to us that a cheap coating and electrical protection would be far more economical than 2.5 cents-per-lb. pitch enamel that would all be lost when the line is removed. The life of these pitch enamels, where they are protected electrically, should be at least 15 years and only one-fifth of their effective life would be used in this manner. On the other hand, for permanent trunk lines we feel that it is much better to use expensive coatings and then apply electrical protection than to use inferior coatings and do likewise. As to the advisability of using electrical protection of practically bare pipe of large diameter already in the ground, again its permanence would determine the course that should be followed. It appears to us as about a five to eight proposition under these circumstances. In other words, it looks as though we would spend five dollars on cathodic protection over a period of ten years where we would spend eight removing the line from service and reconditioning it. If there is a chance that the pipe is going to be moved and placed in other service then we feel that electrical protection is worthwhile. To substantiate this we submit Fig. 2, which shows the leak frequency curve on a mile section of 16-in. pipe during the years 1934 to June, 1938. It will be seen that cathodic protection was established September 23, 1936. The dotted line shows the estimated number of leaks had we not maintained protection on this section. Nothing has been done in the way of coating this line as the company may decide at any time to remove it and place it in service elsewhere. We feel that the results more than justify the expense involved. The dotted line was drawn from our general corrosion leak curves in similar areas where no protection or additional protective coatings have been applied.

Water for Oil-Well Flooding Operations

DR. HARLAN W. NELSON, School of Mineral Industries, Pennsylvania State College, has outlined the characteristics of water suitable for oil-field flooding operations, the method of analyzing the raw water, the methods of treating the water to remove undesirable substances, and the methods of preventing corrosion of equipment by the water.[1]

Water used in flooding oil sands should not contain any substance that might plug the pores of the oil sand. Most natural water requires some chemical treatment to make it suitable for use, the method of treatment depending upon the nature of the water.

Each different water presents a different treating problem, and an analysis of the water is necessary before the proper method of treatment can be determined. Samples of water for analysis should be taken carefully and immediately sent to the laboratory.

Water to be used for flooding oil sands is analyzed to determine the amount of suspended matter, corrosive gases, iron, manganese, and organic growths present, and the corrosive properties of the water.

Suspended matter may be removed by addition of a coagulent, such as alum, and filtration of the resultant floc. The addition of alum to the water lowers the pH and alkalinity of the water, increasing its tendency to corrode the pipe and other equipment. Hence the proper amount should be determined carefully, and no excess added.

The common corrosive gases present in water are carbon dioxide, hydrogen sulphide, and oxygen. The first two can be removed by aeration but the oxygen content would be increased thereby. However, if the water contains a large amount of iron in solution, aeration is the simplest way to convert the iron to an insoluble iron oxide. The analysis of the water will indicate whether such treatment is necessary or desirable. Manganese is similar to iron in its behavior, and its removal is accomplished in a similar manner.

Organisms known as algae are common in water exposed to the atmosphere, and some forms grow rapidly even in the absence of sunlight. One lb. of copper sulphate per 100,000 gal. of water will serve to kill these organisms except in rare circumstances, when the addition of chlorine may be necessary.

Corrosive substances remaining in the water after treatment may dissolve sufficient iron from the pipe to cause precipitation of insoluble iron compounds in the sand. These substances include carbon dioxide, oxygen, and salts such as chlorides. Acidity, or low pH (high hydrogen ion concentration), also promotes corrosion. Treatment with lime will remove bicarbonates, carbon dioxide gas, and magnesium, and will neutralize acidity, but the amount of lime added must be regulated carefully, as excess lime tends to precipitate in the sand as calcium carbonate. Limestone (calcium carbonate) has been substituted for lime with good results in some projects. The water becomes saturated with calcium carbonate and solution ceases. The higher temperature of the oil sand raises the saturation point so that the calcium carbonate remains in solution.

The importance of obtaining the services of a competent analyst is emphasized, as he will be able to assist in selecting proper treating methods.

[1] Water for Oil-Well Flooding Operations, The Pennsylvania State College Bulletin, Circular 10, May, 1938. 17pp.

Running Tour
WITH MEN IN THE INDUSTRY

J. J. McPOLAN, superintendent of the Dallas District of the Magnolia Pipe Line Company, has been made superintendent of the Central Division of the company. **C. E. STILL,** district foreman of the Louisiana-Arkansas District becomes superintendent of the Dallas District. **J. E. McGEATH,** superintendent of the Luling-Mirando District has been made superintendent of the Southern Division with headquarters at Houston, Texas. **R. W. STEWART,** district foreman of the Luling District, has been made superintendent in that area, and **H. C. ALTON,** district foreman of the Mirando City area, has been promoted to superintendent of the Southwest Texas District. **J. G. NORTON,** assistant superintendent of maintenance, has been appointed chief mechanical engineer of the company, making his headquarters in Dallas. **A. W. FREY** becomes the new assistant superintendent of maintenance. **F. G. WHITE,** chief gauger of the East Texas District, has been promoted to district foreman of the Louisiana-Arkansas District with headquarters at Shreveport, Louisiana. **D. R. FORD** becomes chief gauger of the Central Division, his headquarters being at Longview, Texas.

JOE A. HOLMES, chief petroleum engineer, Standard Oil Company of Venezuela, Caripito, Venezuela, was in attendance at the International Petroleum Exposition at Tulsa last month.

T. A. TRAX, drilling superintendent at Chase, Kansas, for the Gulf Oil Corporation, has been transferred to Centralia, Illinois, as district foreman in charge of production.

DR. F. W. SULLIVAN, JR., recently was made director of research at the Whiting, Indiana, refinery of the Standard Oil Company of Indiana. **DR. W. H. BAHIKE** is assistant associate director.

EUGENE H. DENTON, in charge of drilling and production activities of the Ohio Oil Company in Montana, has resigned to join the staff of the Anglo-Canadian Oil Company, Ltd., an Alberta company.

GEORGE F. SMITH has been elected vice-president and treasurer of the Continental Oil Company, and **J. G. DYER** vice-president in charge of production and drilling east of the Rocky Mountains, it has been announced from the company's offices at Ponca City, Oklahoma.

GEO. F. SMITH

Election of George F. Smith to a vice-presidency follows 31 years as an employee of Continental Oil Company, the last 19 years of which he has served as treasurer. J. G. Dyer, one of the youngest executives of a major company in the oil industry, has been manager of Continental's production department east of the Rocky Mountains since February, 1935, and becomes a vice-president at the age of 35.

J. G. DYER

A. T. RYNALSKI, assistant general superintendent of the Lago Petroleum Corporation's refinery at Aruba, Dutch West Indies, has returned to his headquarters following a business trip to the United States.

S. STANLEY LEARNED, who has been assistant chief engineer of the Phillips Petroleum Company, Bartlesville, Oklahoma, recently was made chief engineer of the company. He succeeds **A. H. RINEY,** who has been elected vice-president of the company. Learned has been with the Phillips organization since 1924 and was in charge of design and construction of the gasoline pipe line constructed in 1930 by his company from Borger, Texas, to East St. Louis, Illinois.

R. E. HOLCOMB is in charge of the office recently opened in Los Angeles, California, by the Sunray Oil Company. He formerly was in the land department of the company at its Tulsa, Oklahoma, headquarters.

JAMES KENNETH MURPHY has been appointed chief geologist of the British American Oil Producing Company, Tulsa, Oklahoma. He has been a geologist with the Home-Stake Companies.

WINFIELD GIVENS, district manager for the Sun Oil Company, has transferred headquarters of himself and staff from Mattoon, Illinois, to Evansville, Indiana. The district embraces Sun production activities in Illinois, Indiana, and Kentucky.

G. T. RHODEN, district superintendent of production at Cleveland, Texas, for the Gulf Oil Corporation, has been made assistant division superintendent for the South Louisiana area and transferred to Harvey, Louisiana. **J. C. CADDEL,** formerly assistant district superintendent in South Louisiana, has been sent to Cleveland to take over Rhoden's vacated post.

JOHN VETTER has been appointed superintendent of the recently-consolidated land and geological departments of the Pan-American Production Company, Houston, Texas. **G. J. SMITH** is assistant superintendent for geology under the new arrangement, and **V. I. GRISHAM,** formerly with the Shell Petroleum Corporation, is Vetter's assistant for land.

H. P. TAUBMAN, president of the Buffalo Oil Company, has moved his headquarters from Tulsa, Oklahoma, to Dallas, Texas.

RALPH D. COPLEY, assistant manager, Producing Division, Northern District of the California Company, of Denver, Colorado, was in attendance at the International Petroleum Exposition and also the A.P.I. Midyear Meeting last month.

To PRODUCTION ENGINEERS

EIGHT FACTS YOU SHOULD KNOW ABOUT THE MARTIN-DECKER PUMP DYNAMOMETER

In 1929 Martin-Decker presented the first Pump Dynamometer for oil field use. Since that time progressive oil companies everywhere have relied more and more on this scientific instrument for quick and **positive** diagnosis of oil well pumping troubles. With its aid they have increased production... lowered power costs... lengthened the life of equipment... and achieved maximum production efficiency **with scientific accuracy.**

Here are eight important facts you should know about this instrument:

1. ACCURACY

The Martin-Decker Pump Dynamometer is inherently accurate. The calibration curve is a straight line with negligible **hysteresis.** Calibration is not materially affected by reasonable variations in the volume of fluid in the system. Recent tests at various pumping speeds show time lag to be negligible with the new type non-expanding tubing.

2. RUGGEDNESS

The Martin-Decker Pump Dynamometer is an **oil field instrument.** It does not require "laboratory" conditions and care. For example, during a recent test by a major oil company the polish rod parted. The pressure transformer was catapulted into the air along with the pump adjuster and other well equipment, but repairs were made by an oil field welder at a cost of 75c! The operator, in his normal position at the recorder behind the Samson post, was out of danger. As tests are most commonly made on overloaded wells, this safe position for operator and recorder is important.

3. EASE OF INSTALLATION

The Martin-Decker Dynamometer is easy to install and requires less than two minutes shut-down time. Special levers are placed on top of the regular rod clamp, an extra clamp goes on top of the levers, the regular clamp is loosened, and the job is done!

4. ZERO LINE

The Martin-Decker Dynamometer draws its own zero line with all corrections automatically made. Cards without accurate zero lines are of little use.

5. DEPENDABILITY

We do not know of a single Martin-Decker Pump Dynamometer, regardless of age, that is not in actual field use today. During the nine years the instrument has been manufactured, the total charges to customers for maintenance, including parts and replacements, has been practically negligible. We believe maintenance costs for the Dynamometer have set a new low for oil field instruments.

6. COST

The sales price of the Martin-Decker Dynamometer depends on what the operator desires, but, when scaled down to the bare necessities for properly weighing a well, amounts to a surprisingly small sum. If the cost is distributed over a period of ten years (conservatively estimated as the depreciation period of the instrument) the cost would be $6.25 per month. If the instrument is kept busy, as it can and **should** be, the depreciation becomes less than 5c per test!

7. BENEFITS

The operator who systematically uses the Martin-Decker Pump Dynamometer may expect to show (1) lower lifting costs, and (2) increased production, through his ability to isolate and quickly remedy pumping troubles with scientific accuracy. The operator using the Dynamometer properly is able to secure valuable records of each well's characteristics not obtainable any other way.

8. RECOMMENDATIONS FOR USE

The Dynamometer by itself can be of no benefit to the operator. But it pays tremendous dividends in the hands of a capable engineer — not necessarily an engineer of long field experience, but one who has a good general understanding of the functions of an oil well pump and a string of sucker rods.

For a company contemplating the use of the Dynamometer, we recommend a man be delegated to Dynamometer work alone. Every pumping well offers money-making and money-saving possibilities, and when a man can give adequate time to the study of data obtained with a Dynamometer the operator gets the full measure of benefits from this valuable instrument.

MARTIN-DECKER CORPORATION

LONG BEACH, CALIFORNIA

San Joaquin Valley: A. F. McQuiston, BAKERSFIELD, CALIFORNIA
Mid-Continent Distributor: REED ROLLER BIT COMPANY, Houston, Texas

LAUGH WITH BARNEY

Edited by BARNEY HORRIGAN

Two sailors pretty well stewed went to Loews the other night. The manager not wanting to run a risk in putting them out finally got them upstairs in a little-used lounge room, sitting on a couch which directly faced a street window. This window directly faced the window of a room in a hotel across the street in which room were a bridal couple who had been married that afternoon and had neglected to pull down the window shade. After a minute or two in the dark, one of the sailors aroused a little, blinked his eyes, stared for a moment, nudged his mate and said: "Shay, pretty good show after all." His mate just grunted and the first sailor again fell asleep. After two hours the first sailor aroused again, blinked his eyes and again stared at the sight before him. He grabbed his mate by the arm, shook him and said: "Come on, let's go, this is where we came in."

A diplomat is a person who can tell you to go to hell in such a tactful way that you'll look forward with pleasure to making the trip.

The reason modern girls are such live wires is that they have such little insulation on.

His boss fired his new stenographer because she was too speedy—300 words a minute and all of them "No."—*The Core Driller.*

Title of this month's ditty: She Was Only a Girdlemaker's Daughter, But She Lived Off the Fat of the Land.

Dentist: Don't open your mouth so wide. I'm only going to work in it with my fingers. I stand outside.

How to Get on Relief

"I don't suppose you don't know of nobody who don't want to hire nobody to do nothing, do you?

"I am seeking your daughter's hand, sir, have you any objections?"

"None at all, only take the one that's always in my pocket."

A mountain lion descends a tree head first. A cat, on the other hand, usually comes down backwards. Making it easy to tell the difference.

The gum-chewing girl
And the cud-chewing cow
Are somewhat alike.
Yet different somehow.
What is the difference?
Don't you see it now?
It's the thoughtful look
On the face of the cow.

"How soon shall I know anything after I come out of the anesthetic?"

"Well, that's expecting a lot from the anesthetic."

"Who was that lady I seen you outwit last night?"

Two dairies were rivals for trade.

One of the companies engaged a daredevil motorist to drive a car around the town for 100 hours without sleep. The management decorated the car with large placards reading:

"This daredevil drinks our milk."

The rival company came out with placards twice as large, reading:

"You don't have to be a daredevil to drink our milk."

A Scotchman had to send an urgent telegram, and not wishing to spend more money than necessary, wrote like this:

"Bruises hurt, erased afford erected analysis hurt too infectious dead." (10 words).

The Scotchman who received it immediately decided it was: "Bruce is hurt. He raced a Ford. He wrecked it, and Alice is hurt, too. In fact, she's dead." (19 words).

Here lie the bones of sailor Jack
Who, shipwrecked on this isle,
With six redhead chorus girls,
Remained for quite a while.
He did not die from tropic foods
Nor from the poisoned cup;
He just wore out from tearing down
The signals they put up.

He: Am I a man or a mouse?

She: You must be a man. You don't scare me.

Sign In Boarding House

Please Clean the Tub After Bathing.
The Landlady.

Judge: On what grounds are you applying for divorce?

Mr. Brown: Extravagance, your honor."

Judge: Extravagance, how's that?

Mr. Brown: She kept right on buying ice after I bought her an automatic refrigerator.

Visitor: So you say that the water you get here is unsafe?

Native: Yeah.

Visitor: Well, tell me, what precautions do you take against it?

Native: First, we filter it.

Visitor: Yes.

Native: Then we add chemicals to it.

Visitor: Yes.

Native: And then we drink beer.

Professor: Can you give me an example of a commercial appliance used in ancient times?

Student: Yes, sir; the loose leaf system used in the Garden of Eden.

Adam Counted His Ribs

Adam, after awakening from a deep sleep and viewing for the first time his helpmate in all her marvelous beauty, smiled broadly in amazed admiration as he began to count his remaining ribs.

"I wonder," he mused, "if a man can do without all his ribs."

A minister on a westbound train was reading his Bible when a man leaned over the back of his seat and said: "I don't believe a word in that book." The minister ignored him and presently he repeated in a louder voice, "I don't believe a word in that book."

Losing patience, the minister turned and looked at his interrupter. "My good man," he said, "would you mind going to hell quietly?"

Sandy was thinking of getting married, but wanted to be sure that the girl of his choice was thrifty.

So one night, when out walking with her, he said, "Maggie, I ken a lassie that reads for 'oors in her bed at nicht and wastes a lot of gas. Do you read in bed?"

"Only when it's a moonlicht nicht," she replied. A week later they were married.

Acid Test FOR TRUCKS

104 International Trucks Prove Their Stamina *OFF THE HIGHWAY* for Dowell, Incorporated

You get the real measure of a truck when it goes to work in the oil country.

Dowell, Incorporated, who make a business of treating oil wells with acid to increase production, are up against some of the toughest transportation problems in the world. Hard roads and oil wells seldom get very close together. The type of equipment used by Dowell in "acidizing" oil wells is big and heavy. This means cross country trucking from highways to oil rigs with little or no roadway under the wheels. Dowell's fleet of 104 Internationals, of all sizes, masters these jobs in important oil fields all over the North American Continent.

And just as Dowell's special treatment of acids and chemicals overcomes natural barriers INSIDE the earth, Dowell's great fleet of Internationals overcomes the natural barriers on top. This combination has treated some 11,000 wells in the last five years to produce a gain of over $50,000,000 in the oil industry.

And so it is everywhere—in every line of business, where hauling is a factor, International Trucks show the way to profitable operation. Try this quality product in your own business and see.

The complete new line of Internationals covers every trucking need from store delivery to oil well delivery. From Half-Ton to powerful Six-Wheelers, they are all new ALL-TRUCK trucks, engineered for brilliant performance and styled for brilliant appearance. See the New Internationals at any International dealer or branch showroom. Then put the one you need up against your own toughest test and *watch it work!*

INTERNATIONAL HARVESTER COMPANY
(INCORPORATED)
180 North Michigan Avenue Chicago, Illinois

Dowell fleets, varying in size and equipment according to the territory served, include pumper, winch, and tank-equipped heavy-duty trucks; four-wheel trailer tanks; big six-wheel tank-equipped transport trucks; and pick-up trucks.

INTERNATIONAL TRUCKS

MACHINERY and EQUIPMENT

Rectorseal Thread Compound

RECTOR Well Equipment Company, Fort Worth, Texas, announces the manufacture and marketing of Rectorseal, a thread dope that has been especially developed for use on threaded connections in the oil industry.

This new thread protective compound does not have a petroleum base, and is described as being insoluble in all petroleum products. It is recommended for use wherever there are threads; on gas, gasoline, oil, water, and mud lines, on steam lines that carry a temperature to 400 deg. fahr., and on tool joints. A 1-gal. container of Rectorseal is recommended as sufficient for treating the threads on 2000 ft. of 7-in. casing.

Rectorseal is not intended as a competitive product to thread compounds developed by oil companies for such purposes as applying to pipe threads to prevent rust while the pipe is on the rack, but to serve those special jobs for which Rectorseal was made.

Rectorseal comes in containers of two sizes: for sale in 1-gal. cans, and shipped in ½-pint cans with all Rector casingheads.

Tests have been made following the application and setting up of Rectorseal on pipe having the threads cut entirely through, with the treated threads showing no leak under 4000-lb. pressure, the manufacturers state.

A descriptive folder, giving full details of this new thread dope, will be supplied upon request to Rector Well Equipment Company, Fort Worth National Bank Building, Fort Worth, Texas.

Goodrich 48-60 Combination Belt Vulcanizer

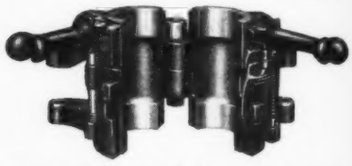
A NEW light-weight, low-cost vulcanizer for vulcanizing belts up to 60 in. in width has been introduced by The B. F. Goodrich Company, Akron, Ohio. It is known as the 48-60 Combination Vulcanizer; weighs only 1650 lb.; has a total wattage of 5000 watts. This new vulcanizer is similar in appearance to the Goodrich double platen, water-cooled type except that it has only three hinged bolts at each side instead of six. It is not made on the bias, but is rectangular in shape. The platens are 65 in. wide and 12 in. long. This makes it possible to place the vulcanizer at a 10-deg. angle on a 60-in. belt, at a 22-deg. angle on a 54-in. belt, and at a 30-deg. angle on a 48-in. belt.

Two advantages are gained by placing the vulcanizer at less than a right angle to the edges of the belt. First, any slight inequalities on the surface along the margin of the vulcanized portion will pass over the pulleys at an angle instead of straight across, and this gives much longer life to the splice. Second, placing the vulcanizer as nearly as possible parallel with the splice angle reduces the number of heats necessary to complete the splice.

The 48-60 Combination Vulcanizer can be supplied for either 110 or 220 volts, but no one machine is adaptable to both voltages.

Drill Pipe Elevator

GREATER speed and safety are claimed for the new drill pipe elevator offered by American Iron and Machine Works Company, Oklahoma City, Oklahoma, and Houston, Texas. One of the features is the improved latch that enables the operator to unlatch the gate by moving right or left handle slightly away, thus preventing any damage to fingers and hands, it is stated. Another feature is that the elevator can be used for either fourble board or finger board racking.



The equipment is made with a universal swivel joint that allows alignment of elevator on pipe to the extent that badly-worn tool joints can be pulled with the elevator without danger of breaking the jaws apart and causing an accident.

The universal swivel joint, as well as all other parts, can be repaired or replaced on the derrick floor.

Electrode for Welding Manganese Steel

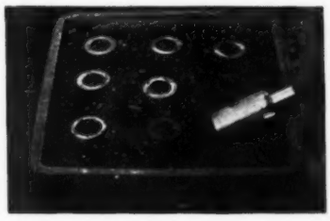
THE Harnischfeger Corporation, Milwaukee, Wisconsin, announces Smootharc "Harmang," an addition to its line of Smootharc welding electrodes. It is designed for welding on parts subject to heavy impact, such as manganese castings, railroad frogs and crossings, dipper teeth, etc. Its base metal is nickel manganese steel, ranging from 11 to 14 percent nickel manganese, 3½ to 4½ percent nickel. Carbon content exceeds 1 percent.

The slag coating, which stabilizes the arc and protects the metal against loss of carbon and manganese, is held to a minimum so as not to interfere with the rapid cooling required to form an austentitic deposit. With cold working, such as hammering and peening, the soft manganese deposit becomes an extremely hard martensite layer that offers great resistance to impact and abrasion. Smootharc "Harmang" operates with the work negative and the electrode positive, and is built in sizes from ⅛-in. to ¼-in. diameter, for use with currents ranging from 90 to 140 amperes. Further information concerning this new welding electrode may be obtained by writing the Harnischfeger Corporation, 4400 West National Avenue, Milwaukee, Wisconsin.

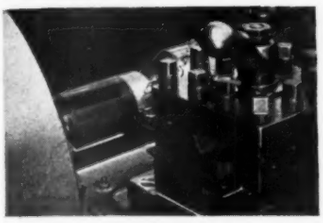
OIL IS LIFTED to a NEW LIFE ON WINGS OF AXELSON CAGES

1. Axelson Heavy Duty Cages are formed from bar stock after which milled areas between the wings are produced on duplex milling machines.

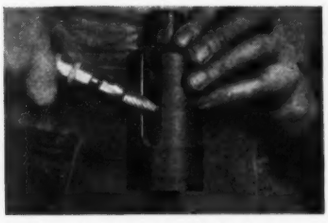
2. Semi-finished bore and measurements of milled areas are checked for accuracy by inspectors.



3. The semi-finished cages are carburized by pack hardening in a solid carbonaceous material.



4. After carburizing the outside surface, the main body and the pin of the cage are turned to remove the carburized surface.



5. The carburized surface for the threaded portion on the inside is removed by boring. Burrs are removed with rotary file.

6. At this point of processing, cages are heated in an electric furnace to proper temperature, and quenched in oil.

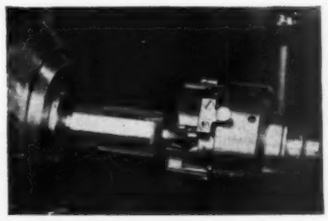
7 After hardening by quenching, the cages are drawn in a Homo electric furnace and checked for proper Rockwell hardness.

8. Cage threads to API specifications are tapped in lower end of cage after cage has been finish reamed to size.

9. The outside diameter of both body and pin of cage are finish ground to size on center and checked for proper tolerances.

Only a part of a pump, but note the care given to it in each of the thirteen operations illustrated, out of a total of fifty required. Dozens of other parts are needed to complete the pump, and each part requires many honest and unhurried operations—hundreds in the finished unit.

Equipped with the finest tools and machinery, Axelson factories are keyed to precision production. Here a thousandth of an inch is a big dimension. Not only are important parts checked to close tolerances, but also the tools that make them are being constantly inspected for accuracy. That's why it is safe and economical to buy Axelson products—anywhere on earth.



10. API specification sucker rod pin threads are produced on cage pin and gaged with both "Go" and "No Go" ring gages.

11. Inside diameter of wings is ground to permit diametral clearance of .040" to .050" when using standard API ball.

12. Checking radius of pin collar with precision radius gage is included as one of the many final inspections.

13. Cages are stamped, washed, oiled and then placed on steel shelving ready for assembling in pumps or shipment as spares.

THERE IS NO ECONOMICAL SUBSTITUTE FOR QUALITY

AXELSON

DEEP WELL PLUNGER PUMPS

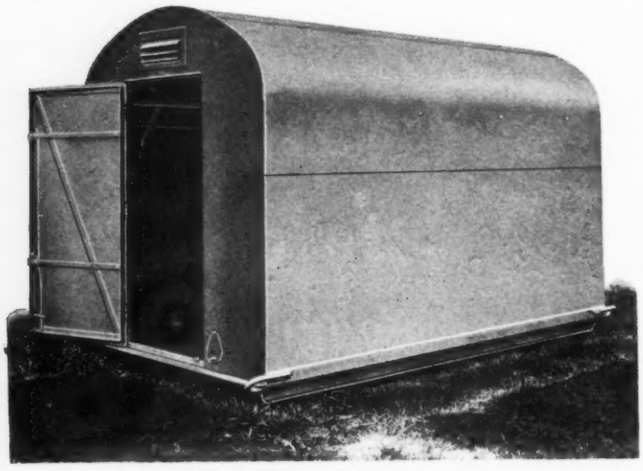
SUCKER RODS

Axelson Manufacturing Company, P. O. Box 98, Vernon Station, Los Angeles • St. Louis • 50 Church Street, New York • Tulsa

Mid-Continent and Eastern Distributor: Frick-Reid Supply Corporation • *Rocky Mountain Distributor:* Great Northern Tool & Supply Company.

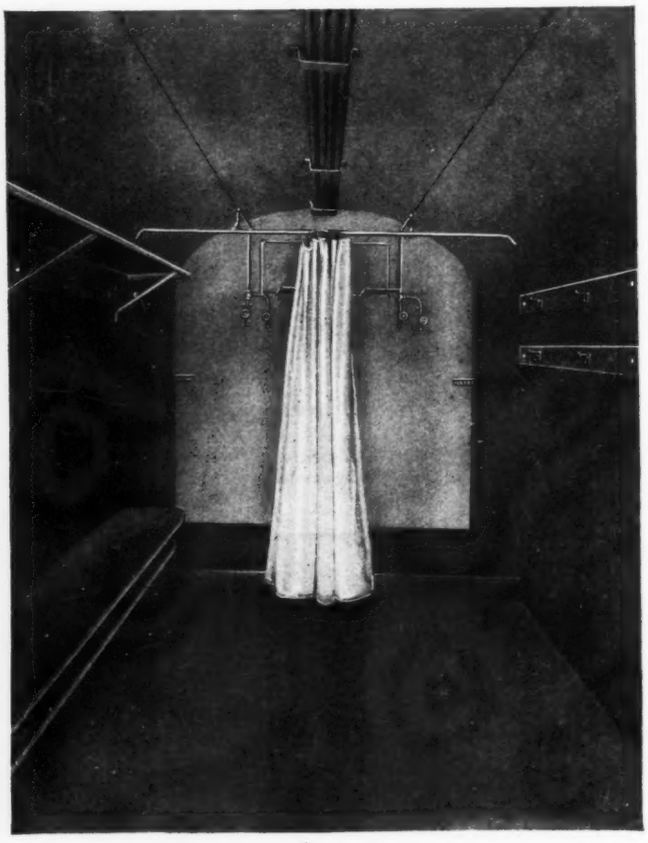
Tool House Converted to Bath House

IN line with raising the standard of living in the oil fields, Wyatt Metal and Boiler Works, Houston and Dallas, Texas, has converted the interior of Wyatt's steel tool house into an ideal bath house, as pictured here. The field worker, coming off tour, may now have his hot shower in winter and cold shower in summer, promoting better health, better spirit, and better working conditions.



Exterior View

Description of this unique bath house is as follows: Welded steel construction. Size 7 ft. by 10 ft. by 7 ft. 6 inches. Weight 2250 pounds. Piped for hot and cold water. Wired for electricity. Equipped with shower curtain, safety wooden floor slatting, bench, shelves, and clothes hooks. Threaded drain outlet provides for piping bath water to distant point. Two adjustable ventilator ports in shower end permit easy temperature regulation aided by a ventilator over the door. It is complete with welded-on hooks to facilitate loading. I-beam skids serve as foundation, and facilitate moving of location.

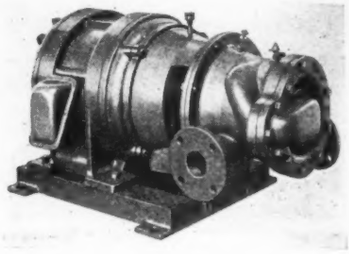


Interior View

Full details may be had by writing the manufacturer, requesting the pictorial bulletin describing both the Wyatt bath house and the Wyatt tool house. The latter can be used as a field office on wildcatting jobs where permanent buildings are not available.

Two-Stage "SSUnit" Type Centrifugal Pump

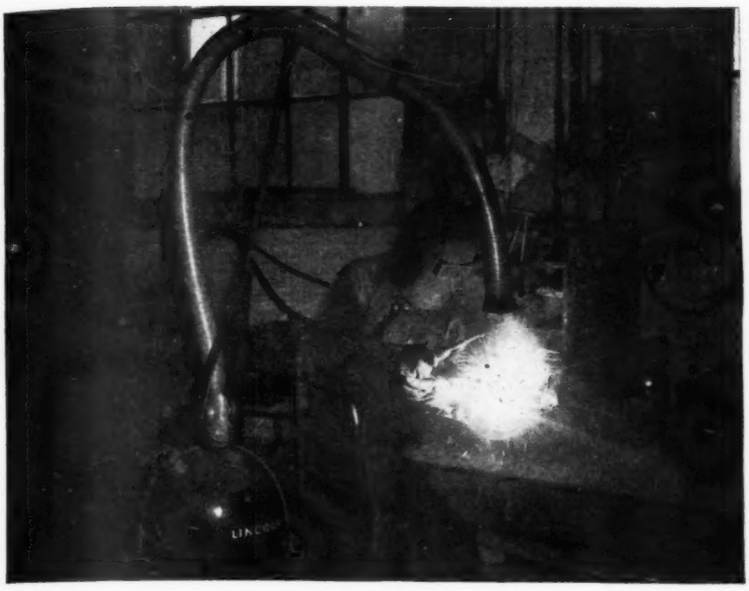
ALLIS-CHALMERS Manufacturing Company, Centrifugal Pump Division, Milwaukee, Wisconsin, has supplemented its complete line of single-stage "SSUnit" type pumps by adding a 2½-in. by 1½-in., two-stage "SS-Unit" type pump capable of heads to 525 ft. at 3550 revolutions per minute. This pump has an efficient capacity range of 50 to 100 g.p.m. against heads of 300 to 500 feet. It is bolted to the motor frame by a splash-proof connection piece, the impellers being mounted on the special motor shaft extension, and the motor bearing also being the pump bearings as in their usual "SSUnit" construction.



This pump is available with motors of 10 to 30 hp. of the standard squirrel-cage, splash-proof or explosion-proof types, and is a very adaptable pump for small boiler-feed pumps, humidifier pumps in textile mills, air-conditioning service, house pumps, small mine pumps, oil gathering, loading and small pipe-line pumps, and other small capacity, high-pressure services.

It operates with unusual smoothness and the efficiency holds up well over a wide range, the manufacturers state. The standard pump has cast-iron casing and cover, and is bronze fitted. The impellers are placed back-to-back, providing axial balance with the suction impeller next to the motor and the discharge passage from the first stage impeller cast integral with the main casing body and communicating with a passage in the cover leading to the inlet of the second stage impeller. This design permits the cover to be taken off, and the inside parts of the pump to be taken out without disconnecting the suction and discharge piping. Descriptive Leaflet 2314 may be obtained from any Allis-Chalmers office.

Lincoln Electric Develops Air Cleaner



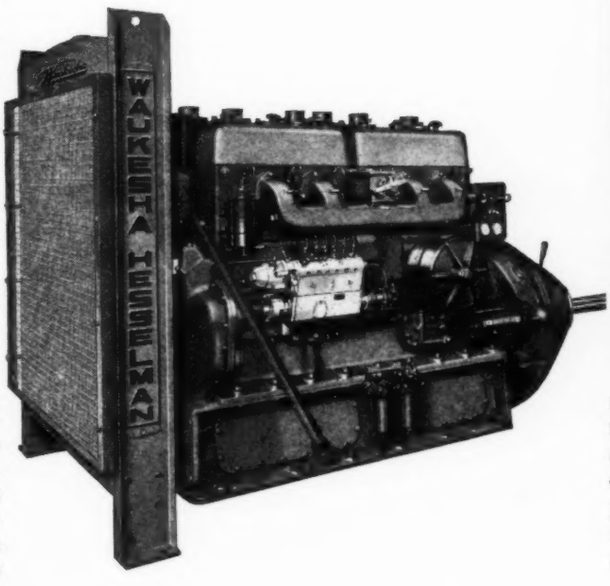
A NEW machine, which conditions air by filtering out dirt particles and which is said to remove approximately 95 percent of the dirt from the air in the vicinity of grinding, welding, and other shop operations, is announced by The Lincoln Electric Company, Cleveland, Ohio.

The machine also draws smoke and heat away from the work, thus contributing materially to the efficiency of welders and to the general improvement of shop conditions. It can also be adapted for blowing smoke away where such operation is desired.

The new air-conditioning machine, known as the "Linconditioner," has been developed to provide work shops economical equipment for cleaning shop air. It removes the smoke and dirt at their source rather than after they have combined with large quantities of air. This requires less power. Also, as no air is taken in or blown to the outside of the building, the new machine conserves plant heat.

Waukesha-Hesselman Drilling Engine

THE Waukesha Motor Company, Waukesha, Wisconsin, announces a new oil-field drilling engine, a 210- to 225-hp. Waukesha-Hesselman oil engine that may be quickly and easily converted to burn natural gas. Known as Model NKH, this engine has six cylinders of 7-in. bore and 8½-in. stroke, and is governed for continuous duty at 1000 revolutions per minute. The engine without accessories delivers 225 hp. full load at this speed, with a reserve output of 235 hp. for intermittent duty at 1050 revolutions per minute. The full load torque is 1185 lb-ft. at 1000 r.p.m., whereas the maximum torque, 1250 lb-ft., is reached at 600 revolutions per minute. This increasing torque as the engine pulls down under load is especially useful in operations that impose sudden momentary overloads, for instead of stalling as a constant torque engine, it pulls through without seeming effort, the makers state.

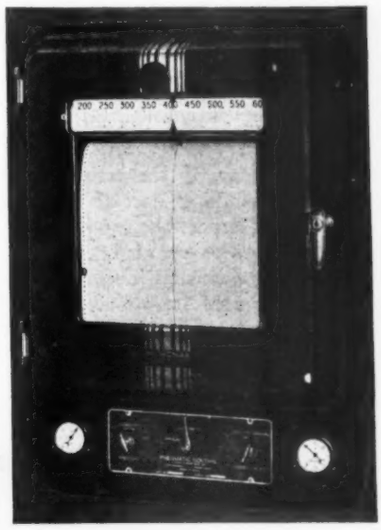


This latest Waukesha-Hesselman incorporates many new features to meet the new demands and rigid requirements of the oil-producing industry.

Model NKH operates at comparatively low pressures—the same as those of an engine specifically designed for natural gas fuel. Thus only a few simple changes are necessary to convert this engine to gas fuel. Major parts—heads, pistons, rods—all remain the same. All that is needed is to add a gas carburetor system to the air intake, remove the floating member of the fuel pump coupling that remains idle, and replace the injection nozzles with screw plugs that fit the holes. The whole job takes less than an hour, and to change back to burn Diesel oil fuel, simply replace the parts removed and reconnect the fuel pump.

Leeds and Northrup Air-Actuated Control

A NEW air-actuated control, developed by Leeds and Northrup Company, is presented in a 12-page catalog—"Micromax Pneumatic Control". Records of actual refinery operation (where this control has already been used with outstanding success to maintain vapor-line temperature of fractionating towers) demonstrate the extremely close limits within which, even in the face of large changes in process conditions, this newest of controls maintains temperature, the manufacturers state.

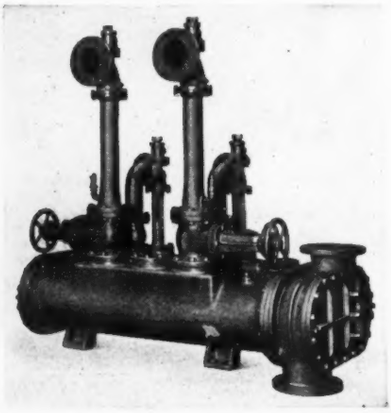


Ask Leeds and Northrup Company, 4934 Stenton Avenue, Philadelphia, for Catalog N-OOB—"Micromax Pneumatic Control."

Improved Steam-Jet Ejectors

IN new literature recently issued, Worthington Pump and Machinery Corporation, Harrison, New Jersey, describes in detail its improved line of 2-stage, condensing-type, single- and double-element steam-jet ejectors.

These 2-stage ejectors have surface type inter- and after-condensers, and are generally used in connection with surface condensers serving turbines in steam power plants. They can also be used in industrial processes where valuable volatile constituents entrained in the gases being compressed can be recovered by condensing them in the inter- and after-condensers. These 2-stage ejectors can also be provided with barometric jet-type inter- and af-



ter-condensers for use in connection with industrial processes.

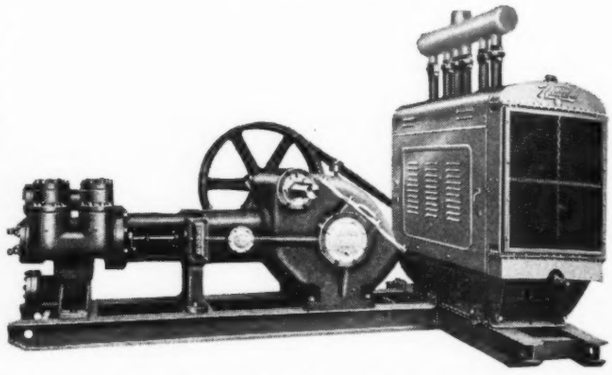
The single-element ejector is used primarily on small units where temporary shut-downs are permissible and where reserve ejector capacity is not essential.

Each element of the twin unit is capable of handling normal capacity, and the unit is provided with suitable isolating valves to permit operation of one or both elements. The spare element can be used for standby service or to take care of abnormal air leakage to the extent of doubling capacity.

Among other improved details, the manufacturer states that these new units are equipped with removable monel steam strainers integral with the nozzle heads, to eliminate clogging of the nozzles and facilitate minor adjustments. Parts subject to high pressure have been fabricated of improved materials, and safety valves are provided on the first stages of twin units to provide protection against closing of the interstage isolating valves at the wrong time. Overall dimensions have been reduced and designs for all sizes standardized. The performance of these improved units is approximately 20 percent better than that of equipment heretofore supplied, the makers state.

Gaso Announces Larger Pipe Line Pump

THE Gaso Pump and Burner Manufacturing Company, Tulsa, Oklahoma, has announced the addition to its line of pumps, of a new 12-in. stroke pump having approximately double the capacity rating of any other Gaso model.

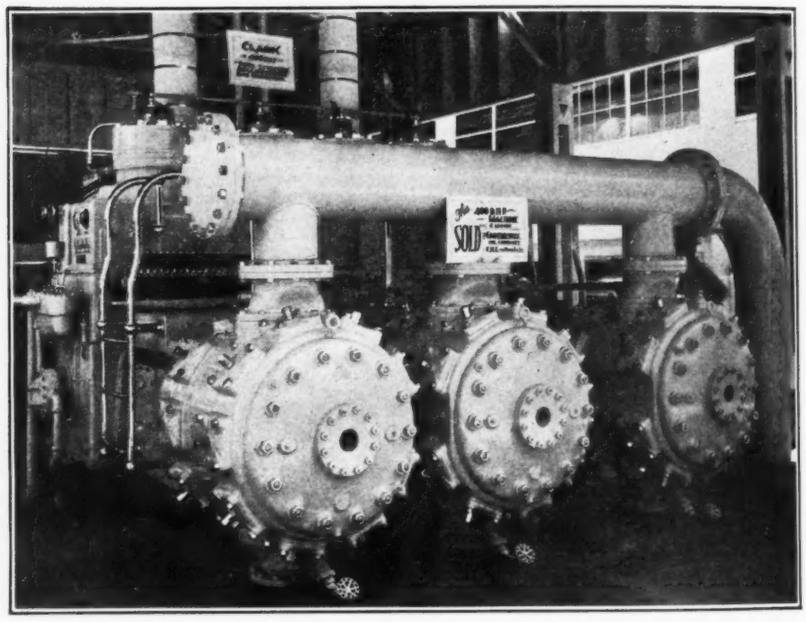


The new pump has fluid cylinders of interchangeable liner type, 4-in. to 7-in. diameter, and capacities from 176 bbl. per hour at 1500-lb. pressure to 592 bbl. at 500-lb. pressure.

The fluid end is of the side-pot type, all valves being individually accessible. Assembled on skids with gasoline engine, the complete unit weighs approximately 24,000 lb., representing, according to Gaso engineers, about the largest semi-portable pumping plant that is practical for pipe-line service.

The new pump possesses the familiar Gaso characteristics of simplicity of design, few, large parts, and rugged construction throughout. Crankshafts are journaled in Timken tapered roller bearings of exceptionally large size, and pinion shafts in Hyatt roller bearings, all roller bearings being sealed off from the crankcase lubricant to prevent adulteration. The pump can be supplied with any type drive, including V-belt drive to electric motor or gasoline engine, direct shaft to engine through flexible coupling, or electric motor through chain reduction gears.

Five Clark 400-hp. Angle Compressors Sold at Exposition



Clark Brothers Company, Olean, New York, reports the sale at the International Petroleum Exposition of the 400-hp. Clark "Super-2-Angle" compressor that was the main feature of the Clark exhibit, as well as four additional units of the same kind. The sale was to the Continental Oil Company to comprise the compressor installation at their new gasoline plant in the K.M.A. field, near Wichita Falls, Texas.

Clark Brothers also sold the complete "water-flooding" unit they had on display, to the Alluwe Oil Corporation, for water-flooding service in Rogers County, Oklahoma. This unit consisted of a Clark "Bobcat" vertical engine and a Clark triplex pump.

Clark Brothers' total sales at the Exposition amounted to approximately $110,000.

Valve-in-Head Tubing Packer

A DEPARTURE from the conventional packer design is found in a valve-in-head tubing packer that has been placed on the market by the Kibele Manufacturing Company, Dallas, Texas, manufacturers of tubing catchers, pump pistons, and swabs.

This new packer does not use slips. It is equipped with Neoprene cups that seal tightly the instant the packer valve is closed and pressure applied. The packer therefore can be raised or lowered or withdrawn from the well with ease as soon as the pressure is released.

A piston valve in the packer head can be locked open or closed. It is shown locked closed in the accompanying illustration. Tubing is turned to the left and lowered when locking and the reverse employed when opening.

Various tests on this Kibele packer reveal that it is ideal not only for all jobs where conventional packers are ordinarily employed but it is also well adapted for air- and gas-lift methods, the manufacturers state. Kibele's success with their flow-head packer, pressure packed, has led to the development of this valve-in-head packer for still more general purposes.

Cooper-Bessemer Type G-MV Compressor

COOPER-BESSEMER'S new Type G-MV compressor unit, a 2-cycle, gas-engine-driven compressor combining V-type power cylinders set vertically, and compressor cylinders arranged horizontally, is an addition to the company's line of engines and compressors. It is rated 100 hp. per cylinder at a conservative speed of 300 revolutions per minute. It is said to be a thoroughly engineered answer to the oil and gas industries' constant requests for greater horsepower in smaller compressor units. Extreme compactness serves to make the G-MV compressor readily transportable, reduces the amount of floor space and materials necessary for its housing, lowers foundation material expense, and makes for welcome ease of installation, the manufacturers state. Shipped completely assembled, except for attaching the compressor cylinders, its factory alignments need not be disturbed and the unit is quickly and easily made ready for operation.

Designed primarily for compressor operations that include compressing air and gas, pumping wells by air- and gas-lift, delivering oil and gas to main lines and transporting them through long pipe lines, repressuring oil sands, and similar operations, these G-MV units also have numerous industrial applications such as supplying power, compressing air and refrigeration gases, and driving generators and pumps.

The builders offer these new compressors in sizes of four, six, and eight cylinders with a range of 400, 600, and 800 hp., respectively. Copies of a bulletin describing the Type G-MV compressor may be obtained from the Cooper-Bessemer Corporation, Mount Vernon, Ohio.

YOUR CREWS WILL LIKE THIS BETTER LINING...

ASBESTOS "CABLES" form the backbone of J-M 420 Rotary Lining. Woven into a compact mass, impregnated and compressed, they make a remarkably efficient and durable lining for heavy-duty work.

IF you've used J-M Rotary Linings . . . and most producers have . . . you know they give smooth, sure braking for a long time at low cost. But here's a *new* J-M Rotary Lining that gives even better service. It's made from an improved weave of "cabled" asbestos yarn, impregnated to increase heat resistance and frictional qualities, and it has these important advantages:—

UNUSUALLY EVEN FEED-OFF, giving better control of drilling . . .

HIGHER BRAKING EFFICIENCY, even at extreme temperatures caused by heavy loads . . .

LONGER LIFE under any conditions . . .

LESS SCORING of drums, giving longer drum life.

Your own drilling rigs will prove the superiority of J-M 420 Rotary Lining. For complete information on this improved lining and on all J-M Friction Materials, write Johns-Manville, 22 East 40th St., New York City.

JM JOHNS-MANVILLE 420 ROTARY LINING

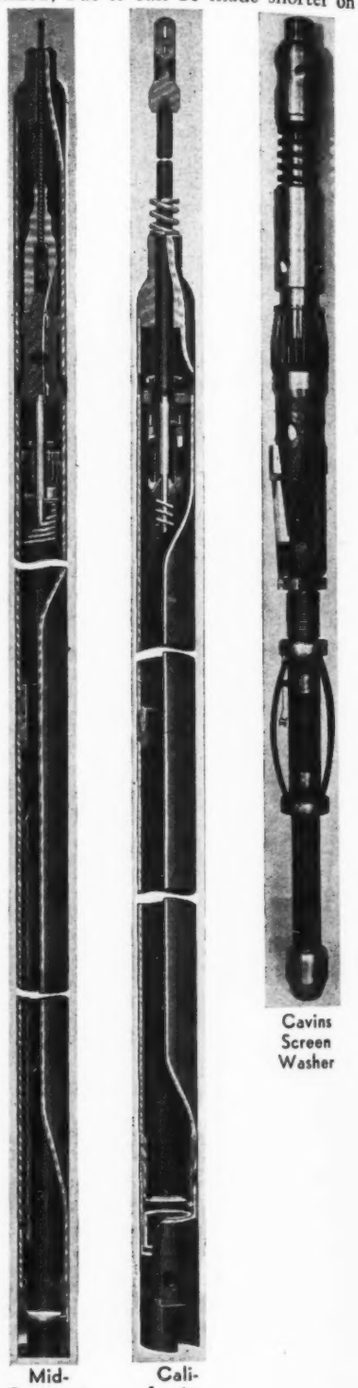
Cavins Sand Pumps and Screen Washer

CAVINS sand pumps are made in two models, the Mid-Continent type and the California type.

The Mid-Continent type is an all-purpose clean-out tool for use in production work or in connection with standard tools where quick change-over features, and ability to stand abuse while delivering the goods, are desired. It is manufactured in sizes of 3⅛, 3¾, 4¾, and 5½ in. O. D. The standard length is 35 ft. overall in two sections, but it can be made longer or shorter according to specifications. It is made of seamless heavy-wall tubes.

Features claimed for this pump are the pressure-equalizing tube that prevents accumulations of dangerous pressures within the load tube; the melo plunger head assembly; the synthetic rubber plunger that resists wear and deterioration by oil, mud, water, etc.; a modified plunger stroke that does not permit working parts to come in contact with recoveries; bottoms of Cavins-Candee or Cavins, featuring the Cavins chisel or flat-bottomed type having two-way flapper valve for easy dumping, bored from solid forgings of chrome-vanadium steel, heat-treated and hard-faced; the split lifting head for quick detachment of rope socket; a swivel rope socket to prevent unravelling of line; and the two-section design that permits ease in handling.

The California type is a general production and clean-out sand pump. The makers say it gets larger recoveries and unloads them automatically, cutting down clean-out time as much as 50 percent. It is manufactured in sizes of 2⅛, 2⅝, 3⅛, 3¾, and 4¾ inches. The standard length of the two sections is 55 ft. overall when extended, but it can be made shorter on

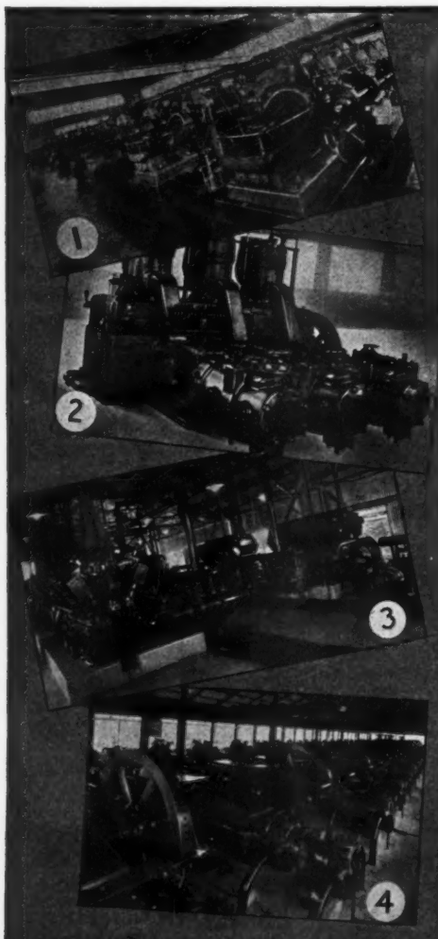


Mid-Continent Type Cavins Sand Pumps

California Type Pumps

Cavins Screen Washer

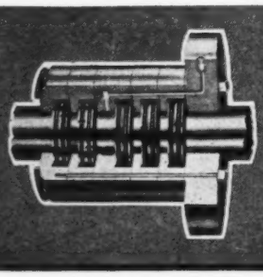
Seal your reciprocating piston rods
the way so many engine and compressor operators do... with
COOK'S METALLIC PACKINGS



1-COOPER-BESSEMER CORP.
2-CLARK BROTHERS COMPANY
3-INGERSOLL-RAND COMPANY
4-WORTHINGTON P&M CORP.

Wherever you may look throughout the oil and gas fields you will find COOK'S Metallic Packings predominating on the power and compressor rods of gas pumping and gasoline extraction engines. Noteworthy applications are represented by the engines, shown in the accompanying illustrations, that come factory equipped with COOK'S modern Packings.

Make sure you get the genuine COOK'S Packings when buying new equipment by specifying their use. For existing equipment communicate with us direct, or our nearest branch office.



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specifications, to run in short derricks, or with pulling masts. It is made of seamless, heavy-wall tubes.

The Cavins Screen Washer is used for flushing out and cleaning screen pipe openings. This equipment consists of a mandrel with slip-actuating device, fluid by-pass valves, and a rubber packer, and is attached to the lower end of the Cavins Bailer.

This device provides a false bottom against which the fluid column of the well is dropped when the slips are set, and the suction chamber valve opened by raising the tool slightly in the pipe and setting back down. The fluid column is dropped against the rubber packer when the suction chamber valve is opened, exerting a very effective force against the screen openings in the immediate vicinity of the rubber packer.

The Cavins Company, 2853-2873 Cherry Avenue, Long Beach California, is the manufacturer of this equipment.

Three G-E Welding Electrodes

THREE new arc-welding electrodes, each protected by a heavy extruded coating, have been announced by General Electric Company's Industrial Department, Schenectady, New York. These electrodes, designated as Type W-20E, Type W-22E, and Type W-23E, respectively, are intended for shielded arc-welding of mild steel.

The Type W-20E electrode is especially designed for general-purpose, single- or multiple-pass arc-welding of mild steel in any position to produce shielded-arc quality in excess of that required to meet paragraph U-69 of the A.S.M.E. Boiler Code. It is particularly suitable for high-speed, single-pass welding and for jobs where fit-up is likely to be poor, the manufacturer states.

The Type W-22E electrode is designed for high-quality, single- or multiple-pass arc-welding of steel in any position to produce shielded-arc quality in excess of that required to meet paragraphs U-68 and U-69 of the A.S.M.E. Boiler Code. Ductility of the deposit is unusually good, and resistance to corrosion is better than that of mild steel, it is stated. This is a fast-melting, smooth-flowing electrode and with it dense deposits can be made without slag inclusions or gas pockets, it is said.

Although vertical and overhead welding with this electrode is usually done with the 5/32-in. size or smaller, the 3/16-in. size can be supplied with two types of coatings, one for overhead and vertical work and the other for horizontal welding. This electrode is recommended for use with direct current (reverse polarity).

The Type W-23E electrode is designed primarily for high-quality arc-welding of mild steel in the flat position to produce shielded-arc quality in excess of that required to meet paragraphs U-68 and U-69 of the A.S.M.E. Boiler Code. Ductility is excellent and resistance to corrosion is better than that of mild steel, it is stated.

This is a high-current, or "hot" rod, so that the weld metal is quite fluid and washes up well on the side walls of deep-groove joints and fillets. Single- or multiple-pass beads can be made at high speeds without slag inclusions or gas pockets. Spatter loss is low and slag is easy to remove, the makers say. This electrode also has a hard flux coating that is not readily chipped or damaged by moisture. A modification of this electrode is also available in coils with heavy taped coating for automatic welding. This type of electrode is recommended for operation with alternating current or direct current (reverse polarity).

A NEW CORE ORIENTATION SERVICE

Sperry-Sun's Polar Core Orientation (U. S. Patents 1,792,639; 1,778,981; 2,089,216; 2,104,752; 2,105,650 and others pending) does not interfere with the progress of drilling. The orientation is determined in our laboratory, to which the selected cores taken by any type of core barrel in the ordinary course of drilling and properly marked, are shipped from any distances. No special equipment is required at the well, there is no loss of drilling time.
New Price List, May 1, 1938

Self Checking SYFO Clinograph

SELF-CHECKING SYFO CLINOGRAPH

A quick, inexpensive daily record of vertical deviation in drilling, without the use of dangerous acids. Used on wire line, as "Go-Devil" or on sand or bailing line. Fully patented.

Self Checking H-K Clinograph

SELF-CHECKING H-K CLINOGRAPH

Designed for open holes only — providing permanent, accurate photographic records of inclination and direction on paper discs five minutes after removing instruments from hole. Fully patented.

Setting a Remarkable Well-Surveying Record!

Continental Oil Company's world's record well at Wasco, California, was **Double Surveyed** to a depth of 11,500 feet with the "SURWEL" Gyroscopic Clinograph on a wire line — the deepest oil well survey ever made.

From the Log

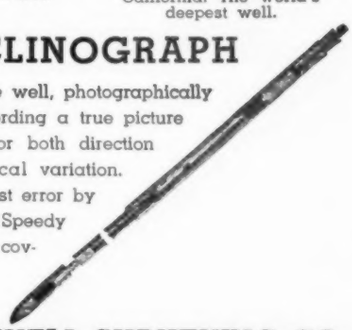
In-run started at	10h 16m 35sec.
Bottom reached at	11h 36m 12sec.
Out-run completed at	12h 53m 47sec.
Total time for two surveys	2h 37m 12 sec.
Closure between In- and Out-run	9.3'
Maximum temperature recorded	210°F.

Records taken every 100 feet.

Continental Oil — K.C.L.A. — 2 Wasco (near Bakersfield), California. The world's deepest well.

SURWEL CLINOGRAPH

provides a map of the well, photographically at all depths and affording a true picture of drilling progress for both direction and degree of vertical variation. Doubly checked against error by "in and out" survey. Speedy and accurate. Fully covered by patents.



SPERRY-SUN WELL SURVEYING CO.

1608 Walnut Street, Philadelphia, Pennsylvania

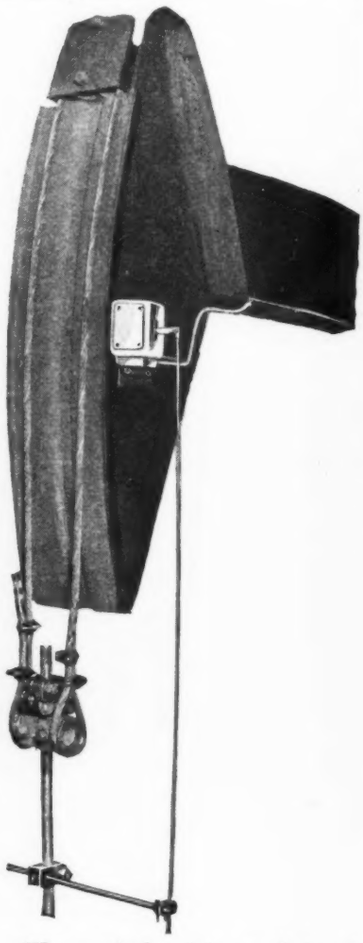
TULSA, OKLAHOMA
425 Petroleum Building
CORPUS CHRISTI, TEXAS
332 North Morningside Drive
HOUSTON, TEXAS
3118 Blodgett Avenue
LAFAYETTE, LOUISIANA
Bank of Lafayette Building
SANTA BARBARA, CALIF.
1409 E. Valley Road
LONG BEACH, CALIF.
549 East Bixby Road
(3800 Block—Atlantic Ave.)
BAKERSFIELD, CALIF.
Care of Elks Club
Seventeenth and I Streets

Cut-Out Switch for Pumping Rig

THE International Derrick and Equipment Company, Columbus, Ohio, has developed and placed on the market the Ideco Cut-Out Switch designed to shut down the prime mover on a pumping well when a part of the pumping rig breaks or gets out of adjustment. This cut-out switch may be installed on a standard rig, a geared pumping machine, a chain rig, or a jack, and may be used to shut down an electric motor or a gas engine of any type.

This device is built in two units, one unit for attachment to the polished rod and the other unit for attachment to the cross-beam equalizer of a twin-crank pumping machine.

The polished rod switch is hooked up in such a manner that it will shut down the prime mover when the relative positions of a point on the well end of the walking beam are changed —either increased or decreased. A double-throw mercoid switch is attached to the well end of the beam, either to the beam itself or the mule head or other type of beam head. The switch lever is held in the normally-open position by a vertical rod clamped rigidly to the polished rod.

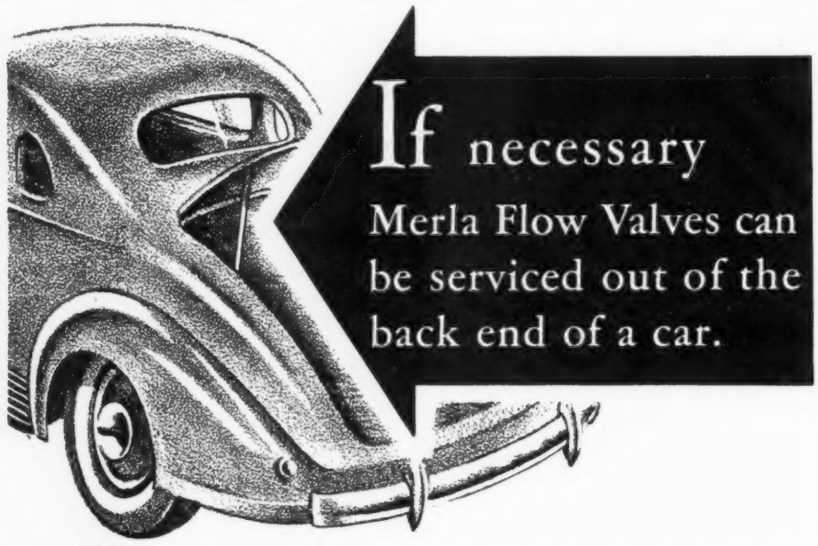


The vertical rod is attached to the switch lever by means of a detachable or breakable connection so that any over-travel in either direction will not damage the switch.

The equalizer switch is applied to one arm of the cross-beam equalizer in a twin-crank pumping machine. If one pitman or wrist pin should break, or if the walking beam should be distorted

transversely from any other cause, the tilting of the equalizer beam in either direction will close the mercoid switch thus shutting down the prime mover.

An alarm circuit may be installed if desired to indicate when any particular well is shut down. A bell or a system of lights may be installed in the lease house or a light at each location.



MERLA FLOW VALVE

WRITE FOR MERLA BOOKLET

An illustrated description of the Merla Flow Valve, also an interesting discussion of the principles of gas lift operation, are contained in the Merla Booklet. Write for a copy. It's free.

Seldom do Merla Flow Valve installations require attention. But sometimes changing characteristics of a well make it advisable to change the differential in the Merla Flow Valves.

This change is easily and quickly made at the well, by *merely changing a calibrated spring.*

Which explains why you hear it said so frequently, "If necessary Merla Flow Valves can be serviced out of the back end of a car."

Back of every Merla Valve is one of the largest and most modernly tooled manufacturing plants of its kind anywhere in this country.

With all its simplicity and sturdiness a Merla Flow Valve meters gas precisely—*as sensitive to pressure and velocity differential as a feather in a breeze* — maintains efficient and economical production.

MERLA TOOL COMPANY

MANUFACTURERS OF OIL FIELD EQUIPMENT

P. O. BOX 2576 DALLAS, TEXAS

Security Hook Collar Liner Hanger

THE Security Engineering Company, Inc., Whittier, California, has a fundamentally new type of liner hanger that has no slips to jam, no complicated setting mechanisms to twist or turn, and nothing to get out of adjustment, according to the makers. It is simple in its setting action and eliminates any danger of hanging the liner too high or too low in the hole, it is stated. Moreover, it is claimed that when set it will not move down the hole under the heaviest liner load.

This new Security Liner Hanger consists essentially of two parts: the hook collar and the liner hanger itself. The hook collar is made up in the casing string so that when the casing is landed this collar will be at the point where the liner is to be supported. The liner hanger makes up on top of the liner and has a number of strong spring fingers equally spaced around its circumference. These springs are so designed that, as the liner is lowered through the casing, the ends of the springs are pressed in and cannot contact the casing surface. This prevents any possibility of the fingers catching in the regular couplings, it is said; however, when the hanger reaches the specially-designed recess of the hook collar, the springs expand, catch on the supporting shoulder, and lock the hanger against further downward movement. Withdrawal is equally simple and positive, for a straight pull on the run-in string contracts the springs and completely frees the hanger.

A feature of the hook collar liner hanger is that, because of its simple construction the liner hanger can be made of "Securaloy" Drillable Metal in addition to the conventional all-steel construction. When made of "Securaloy" the liner hanger can be drilled up and circulated out of the hole when occasion demands, and the short spring fingers (the only steel used in the construction) will fall to the bottom of the hole where they can be side-tracked or picked up with a basket bit.

The Security Hook Collar Liner Hanger is available in either plain or packer types as desired. The plain type is for liner support only, whereas the packer type has a lead seal that packs off inside the casing.

The supporting springs are so mounted in the liner hanger body that each spring end rests against a recessed shoulder. This shoulder carries the entire thrust load of the spring and machine screws, which carry none of the thrust load, serve to hold the springs in place. Each spring in the Security Liner Hanger will carry a safe load in excess of 20,000 lb., it is stated, and the various sizes of hangers are designed with a sufficient number of springs to afford an ample safety margin for the heaviest loads.

As the hook collar becomes an integral part of the casing string it is designed with an outside diameter no greater than the couplings and an inside diameter no smaller than that of the casing. Nothing projects on either the inside or outside of the string to interfere with running the casing or with any tools that may be subsequently run through the casing.

Eliminates WEAR on Tubing and Collars

Prevents Parted Tubing Strings with consequent Fishing Jobs and Losses of Time, Money and Production.

Grizzly Tubing Protectors are made of a special hard, tough substance that wears better than steel; and is absolutely impervious to oil, acids and heat. They protect the tubing and collars against excessive wear in pumping operations that frequently results in parted strings with all the grief of costly fishing jobs, loss of time, labor and production. Supplied in a range of five O.D. sizes for 2", 2½" and 3" tubing. Bulletin No. 14-OF mailed on request.

E. M. SMITH COMPANY

600-650 South Clarence Street, Los Angeles, Calif. Complete Stocks Maintained In Our Warehouses At: 1008 S.E. 29th St., Oklahoma City, Okla. 2311 West Street, Houston, Texas. Export Office: Continental Emsco Co., 30 Rockefeller Plaza, New York, N. Y.

DISTRIBUTED BY LEADING SUPPLY COMPANIES

GRIZZLY TUBING PROTECTORS

Bethlehem Announces New Line of Seamless Tubular Products

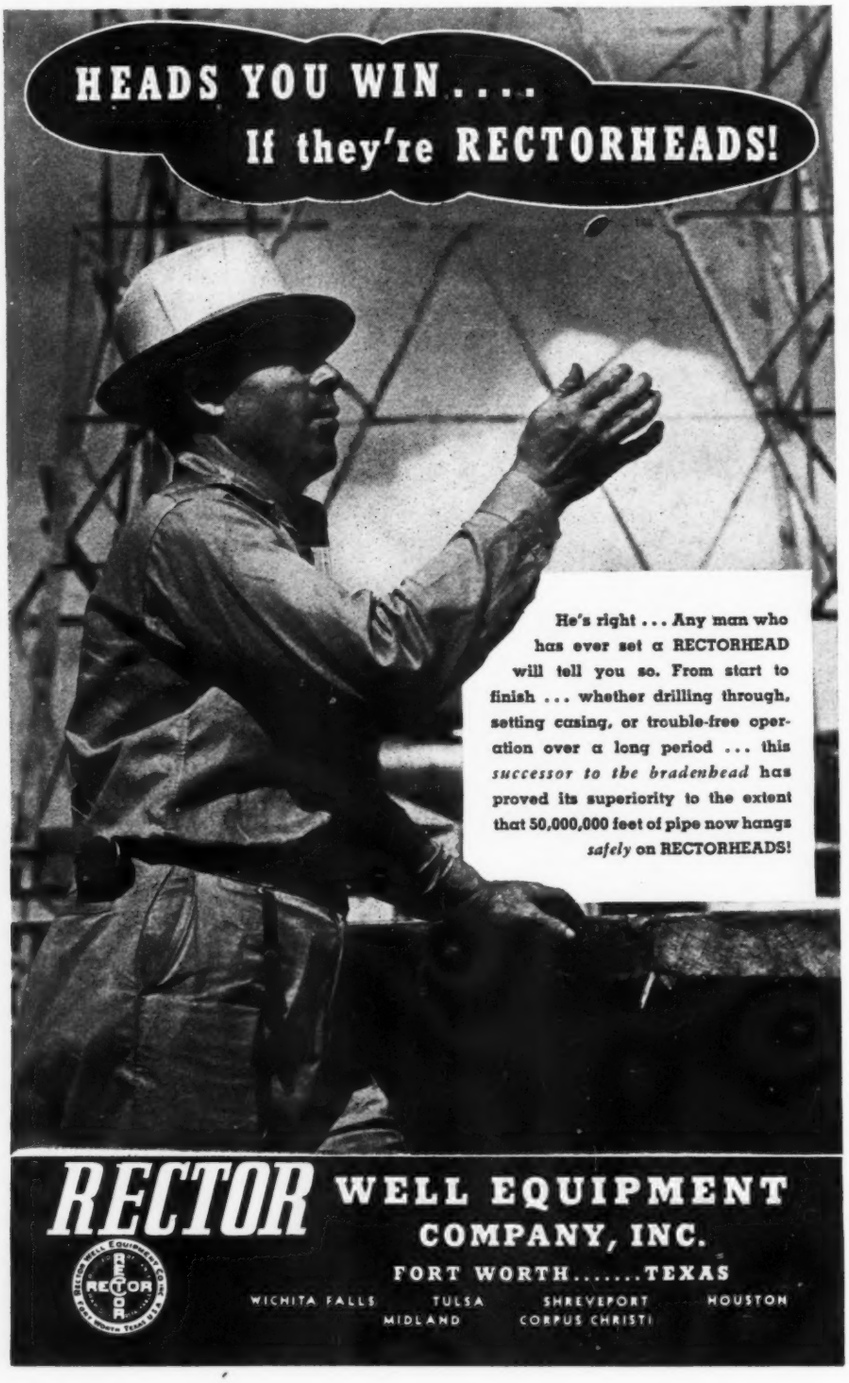
BETHLEHEM Steel Company announces that it has entered the seamless tubing business and is now ready to supply seamless casing, tubing, and line pipe, thus rounding out its line of products for the oil industry.

The new seamless products are made under careful supervision and metallurgical inspection and control. Sample strings, both threaded and coupled and bell and spigot types, have been run in several widely-separated fields, under varying conditions, with excellent results, it is stated.

All standard sizes and types of seamless casing, tubing, and line pipe up to and including 8⅝ in. O.D. are available. A mill depot has been opened at 7200 Clinton Drive, Houston, Texas, where a complete stock of seamless products will be maintained, to insure prompt service. Adequate stock is also maintained at the mill at Beaver Falls, Pennsylvania.

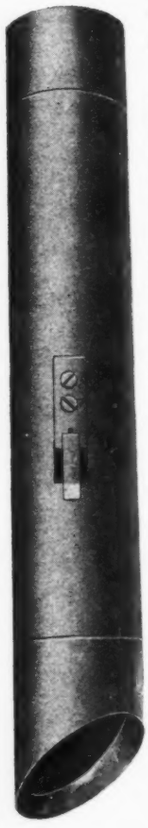
The company will continue the manufacture of lap-welded surface casing, from 10¾ in. to 13⅜ in. O.D. as well as all sizes of lap-welded line pipe to and including 16 in. O.D. These products will also be stocked at the Houston depot.

All of the above-named products are available through Bethlehem Steel Company's regular sales organization, as well as through the facilities of its subsidiary, Bethlehem Supply Corporation, operating in the Mid-Continent and Gulf Coast fields.


HEADS YOU WIN....
If they're RECTORHEADS!
He's right ... Any man who has ever set a RECTORHEAD will tell you so. From start to finish ... whether drilling through, setting casing, or trouble-free operation over a long period ... this *successor to the bradenhead* has proved its superiority to the extent that 50,000,000 feet of pipe now hangs *safely* on RECTORHEADS!
RECTOR WELL EQUIPMENT COMPANY, INC.
FORT WORTH.....TEXAS
WICHITA FALLS TULSA SHREVEPORT HOUSTON
MIDLAND CORPUS CHRISTI

Homco Offers Improved Outside Cutter

THE Cutting and Fishing Tool Division of Houston Oil Field Material Company, Houston, Texas, is now operating the improved C-M-P Outside Cutter as a part of this specialized field service.

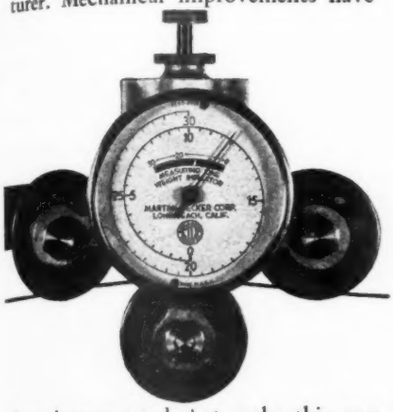


This drill pipe cutting tool is mechanically operated. It employs no wedge ring in its design, the shell of the tool serving as a wedge ring, thereby allowing the operator to go over the pipe to be cut with a minimum of annular space between the tool and the "fish." The cutter assembly works independently of the shell of the tool, thus the distance between the point of cut and the engaged point remains the same. When the operator picks up on the tool, the shell (or body of the tool) moves up over the cutting assembly and forces the knife against the pipe to be cut. The cutter knife is actuated by the inclined plane on the shell, which is substituting for a conventional wedge ring.

In event of failure to make the cut, this tool, according to the manufacturers, easily strips out because only the cutting edge of the knife has to be broken off by reason of it being hinged at the top, instead of the bottom, where the entire knife would lay against the pipe to be cut.

Martin-Decker Measuring Line Weight Indicator

EFFICIENCY and utility have been increased in the new Measuring Line Weight Indicator recently announced by the Martin-Decker Corporation, it is stated by the manufacturer. Mechanical improvements have



been incorporated that make this new instrument simpler and stronger. The sensitivity to small weight changes has been increased and the dial travel has been lengthened to 540 deg. (one and a half revolutions) to give maximum reading accuracy and greater capacity.

The new Martin-Decker Measuring Line Weight Indicator is a great aid in all measuring-line operations, such as locating cement plugs and running instruments and tools on wire lines, the makers state. A new model is also available for torpedo lines and insulated shooting lines. Complete information can be obtained from the Martin-Decker Corporation, Long Beach, California.

Regan Hooks Now Magnafluxed

A NEW development in testing wigle type spring casing hooks is being introduced by the Regan Forge and Engineering Company of San Pedro, California. The hooks are now tested to one and one-half times their rated safe working load by a special machine constructed for the purpose.

A further inspection resorts to the use of a patented process, on which the company has obtained a license. This inspection process, known as the Magnaflux system, is designed to show the positions and extent of cracks that otherwise would be invisible to the naked eye. These cracks, if very small, are machined out so that they do not constitute a starting point for progressive fatigue failure. Otherwise, the hook is rejected. The test and inspection procedure is also being made available to any company with casing hooks already in service.

Non-Skid Flooring and Stair Treads

AN improved type of non-slip safety metal, which is said to be highly resistant to rust and acid corrosion and unaffected in its non-slip properties by water, oil or other slippery liquid substances, is being manufactured by The American Brake Shoe and Foundry Company, New York City. This new product is marketed under the trade name of Non-Slip Absco Metal.

Electric furnace abrasive grains, the best anti-skid and hardest material known, are applied to cast-iron, bronze, aluminum or nickel silver, by a special process of casting. The abrasive grains are deeply and uniformly bonded into the metal at the time of casting, thus forming a virtually indestructible bond between the abrasive grains and the metal, it is stated.

Non-Slip Absco Tread Style No. 512

Non-Slip Absco Tread Style No. 409

A TIGHTER SEAL WITH LESS FRICTION?

YES! when you use SEA RINGS

SEA RINGS are completely automatic. The flexible lip is held tightly to the rod by the pressure on the work stroke, but releases on the return. Unnecessary friction is eliminated, there is less wear on both rod and packing.

INCREASED operating efficiency and less time lost for repacking . . . that is the record J-M Sea Rings have made in plants throughout the country. Three features explain their exceptional service—proper composition, correct design and rugged construction. And these same three features are characteristic of all packings in the complete J-M line.

Johns-Manville, largest manufacturer of asbestos products, is well equipped to make packings of unusual quality. J-M Packings are the result of 60 years' research and experience in the development of materials specifically suited to various mechanical equipment and service conditions. No matter what your packing problem is, there is a J-M Packing that can handle it efficiently, dependably and economically.

The J-M Packings Catalog will help you select the right packing for every requirement in your plant. For your copy, write Johns-Manville, 22 E. 40th St., N. Y. C.

JM JOHNS-MANVILLE PACKINGS & GASKETS

AVAILABLE ON PHONE CALL AT YOUR NEAREST DISTRIBUTOR

Active Plans for 1939 Oil Show at Houston Now In Progress

After making a careful survey as to the desires of those exhibiting at the Houston Oil Show, the executive committee recommended that the next Oil-World Exposition be held in Houston from April 24 to 29, 1939, inclusive At a meeting of the board of directors this recommendation was approved unanimously and all arrangements made to carry out the plans for the 1939 show.

In order to determine the desires of the manufacturers and suppliers of oil equipment, the question was submitted: Do you favor holding the Oil-World Exposition in Houston every two years, alternating with the Tulsa Exposition? Of a total of 221 replies received, 192 companies preferred an exposition held every two years in Houston and every two years in Tulsa. There were 13 companies that wanted the expositions held every four years in Houston and every four years in Tulsa. One manufacturer was satisfied with either arrangement and the rest of those replying to the questionnaire expressed various desires, such as a show every 18 months at each city. In all cases there was a desire for an exposition at both Houston and Tulsa.

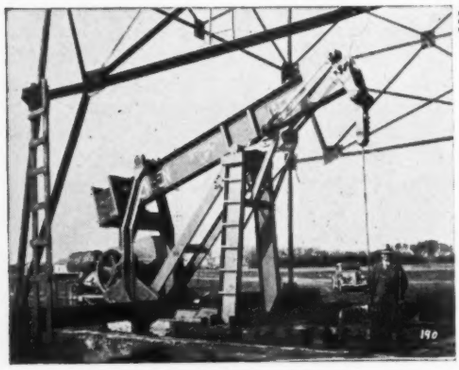
More than 400 exhibiting spaces in the main building have already been contracted for or reserved for the 1939 Exposition in Houston, announces Ed G. Lenzner, general manager of the Oil-World Exposition, Inc. A great number of exhibitors in the 1937 show have increased their space. In order to accommodate the demand for greater exhibiting space, a large annex has been constructed adjacent to the Coliseum where the last show was held. This annex will provide an additional 90,000 sq. ft. of floor space of which 46,000 sq. ft. is on the same level as the main floor of the Coliseum and 44,000 sq. ft. on the ground floor. In addition 13,300 sq. ft. of exhibiting space has been made available in the basement of the Coliseum, which will provide a total of 184,742 sq. ft. or 938 exhibit booths. The buildings are publicly owned and the exhibitors pay only for the rental of the space.

Approximately 50 percent additional outdoor space has been provided adjacent to the Coliseum to accommodate the exhibition of such equipment as derricks, drilling rigs, engines, etc. In addition to those previously exhibiting outside, practically all of whom have reserved space for the 1939 show, a number of other companies have made inquiries regarding large blocks of outdoor space.

Many important meetings and conventions are also being planned to be held during the Exposition. Fifteen meeting rooms have been completed in the Coliseum and a large convention hall is immediately adjacent to this building. The convention hall is air-conditioned, is equipped for sound, has projection booths, a 90-ft. stage, and offers all the facilities desired for any type of meeting. The seating capacity is 2416.

Marley Company Opens New Sales Branch

The Marley Company, water-cooling equipment manufacturers, opened a southeastern sales branch in Atlanta, Georgia, recently. T. A. Tobin, formerly of the home office sales staff in Kansas City, Missouri, is in charge of the new office situated in the Walton Building. The telephone number is Jackson 0974.



TO ENGINEERS ABOUT LIFTING OIL

You've heard about JENSEN JACKS. You've seen 'em run. But have you ever looked into the way they're engineered?

You'd like it. We've made pumping equipment for 19 years. Everything we know goes into these JENSEN Straight-Lift UNITS. Some of the best producers in the business swear by 'em. If you'd like to ask technical questions, write us at Coffeyville. We know the answers.

Wire us at COFFEYVILLE

JENSEN BROTHERS MANUFACTURING CO.
. . . *Coffeyville, Kansas*

THE PETROLEUM ENGINEER'S ANNUAL ENGINEERING REVIEW NUMBER

is to be issued July 1st

Subscription orders received promptly will begin with this issue.

THE PETROLEUM ENGINEER,
Box 1589, Dallas, Texas.

Enter my subscription for one year. My check in the amount of $2.00 is enclosed.

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J. R. Boax Transferred to Oil Well Supply

James R. Boax has been transferred from National Tube Company at Tulsa to Oil Well Supply Company as sales engineer, tubular products, Houston, Texas. Boax was born at McKeesport, Pennsylvania, in 1904, and comes from a family of craftsmen whose life work has been pipe manufacture, both his father and his grandfather having devoted their lives to this work.

JAMES R. BOAX

After graduating from the University of Syracuse, Boax took extension work at the University of Pittsburgh and also completed the three-year training course of National Tube Company, after which he assumed the position of field serviceman and sales engineer for National Tube Company.

Roy Bean with Cameron Iron

Roy N. Bean, formerly with Layne and Bowler Company, has become associated with the sales department of Cameron Iron Works, Inc., Houston, Texas, in the capacity of sales engineer.

Latest Issue of Lufkin Line Contains Many Features

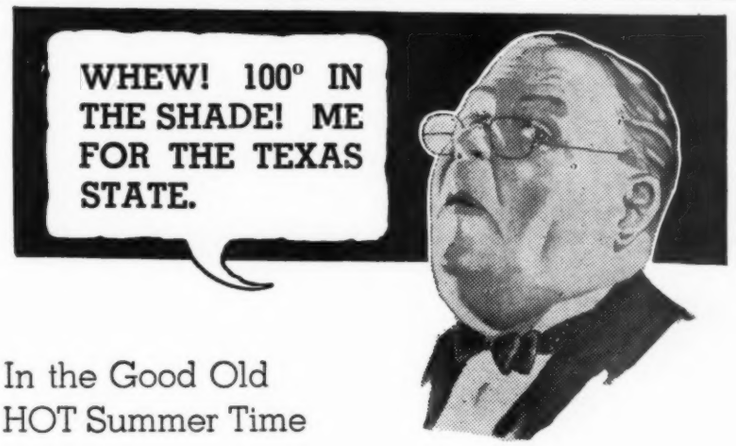
Featuring a most complete and interesting story on the increasing use of automobile trailers for economical tourist travel, for commercial use in bringing the product to the point of sale, and giving facts and figures concerning this comparatively new and growing industry, the current issue of the *Lufkin Line* has just been released for distribution. One very interesting feature of the trailer story concerns the new Mobile Hospital Unit of the California Forestry Medical Corps. This unit, said to be the only one of its kind in existence, brings all of the facilities of a modern hospital to the scene of disaster and is equipped with operating table and cabinet containing more than 200 surgical instruments.

The largest trailer in the world is described, and the use of trailers in the movie industry is told and illustrated in real Hollywood fashion.

In addition to the trailer story, the magazine is replete with snapshots of various oil personalities and imitating the magazine, *Life*, a new department has been added featuring snapshots of a recent A.P.I. meeting entitled: "Lufkin Goes to a Party".

An Interesting and enlightening story on Bermuda and the pleasures to be found on this unique group of islands is also included in this issue.

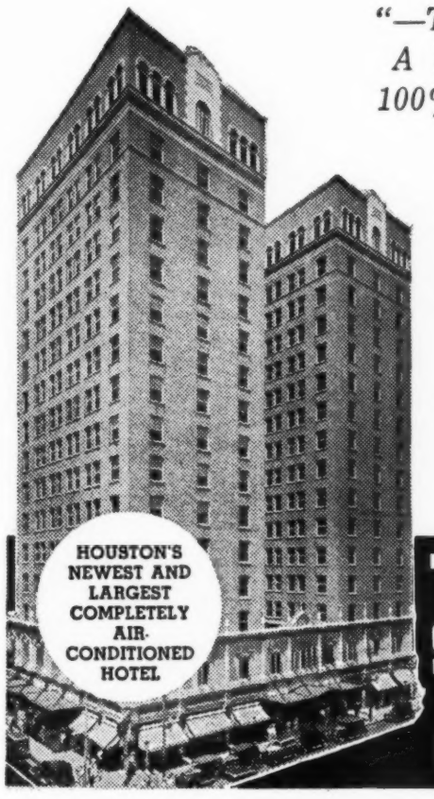
The *Lufkin Line* is distributed without cost to oil men everywhere upon request to the home office of the company in Lufkin, Texas.



In the Good Old HOT Summer Time

Guests Want Real Comfort

"—That's Why I Chose A Real Hotel That's 100% Air-Conditioned."



At the Texas State each guest can regulate his own room temperature. Cool, refreshing, restful nights are assured. No chilly drafts. No clammy, stale air. Instead, always an abundant supply of fresh pure outside air, crisp and invigorating to keep you comfortable.

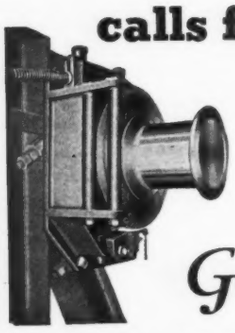
Come to the Texas State and enjoy your next Houston visit. Every room has both tub and shower. Attractive low rates always.

B. F. ORR, Gen'l Mgr.

TEXAS STATE Hotel HOUSTON

MODERN DRILLING

calls for a



Geared

CATHEAD

The high speeds at which many line shafts are being run in today's drilling operations makes it practically imperative that a cathead be geared down to reduce the terrific impact when breaking tool joints. Conventional catheads, when slowed down, lose most of their power, but not the MacClatchie Gearomatic. Due to its patented gear arrangements, it rotates at HALF the line shaft speed yet gives DOUBLE the power.

It breaks the tightest joints with ease and without damage to tongs, tong dies, or other equipment.

A positive kick-out and slow motion insures greater safety. The positive kick-out permits one revolution, and only one, per pull. Consequently, there is no danger of fouled lines injuring workmen or damaging rig equipment when you use the MacClatchie Gearomatic Cathead.

MacCLATCHIE MANUFACTURING CO.

COMPTON, CALIF. HOUSTON, TEXAS

Export:

Geo. R. Woods, 17 Battery Pl., New York

M. L. Jackson to Rector Staff

M. L. Jackson has been appointed division manager of the Rector Well Equipment Company in charge of the north Louisiana and Arkansas district. His headquarters are 631 Spring Street, Shreveport, Louisiana. Jackson joins the Rector organization following five years' field experience at Seminole, Oklahoma, and Rodessa, Louisiana.

M. L. JACKSON

Chapple Manager of New Australian Company of Lincoln Electric

The Lincoln Electric Company, manufacturer of arc-welding equipment, Cleveland, Ohio, announces appointment of J. M. Chapple as managing director of the new manufacturing subsidiary, Lincoln Electric Company (Australia) Pty., Ltd., recently established at Alexandria (Sydney), Australia, by J. F. Lincoln, president of the company. A factory building has been purchased and arc-welding machines, electrodes, and accessories will be manufactured. Chapple will be in charge of manufacturing, sales, and advertising of the new company.

J. M. CHAPPLE

Although a newcomer to The Lincoln Electric Company, Chapple is a veteran in the welding industry, particularly abroad. For 13 years he has been associated with Armco International Corporation, most of that time in foreign service.

SERVE!

A foremost word in Affiliated National Hotels operations. Yet, unlike the national game with two initial chances to serve, we have but one. Our serve, comprising every modern guest service and comfort, is most accurate .... for hosts of friends have been won. Let us serve you!

Affiliated

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JUNG HOTEL ..... New Orleans
HOTEL DESOTO ..... New Orleans

MISSISSIPPI

HOTEL LAMAR ..... Meridian
HOTEL RIVIERA ..... Biloxi

NEW MEXICO

HOTEL CLOVIS ..... Clovis

OKLAHOMA

OKLAHOMA BILTMORE ..... Oklahoma City
HOTEL HUBER ..... Muskogee
HOTEL BELMONT ..... Okmulgee
HOTEL SAPULPA ..... Sapulpa
HOTEL ALDRIDGE ..... Wewoka

TEXAS

STEPHEN F. AUSTIN ..... Austin
HOTEL SETTLES ..... Big Spring
HOTEL BROWNWOOD ..... Brownwood
HOTEL SOUTHERN ..... Brownwood
HOTEL LAGUNA ..... Cisco
HOTEL CLIFF TOWERS ..... Dallas
HOTEL DONNA ..... Donna
HOTEL CORTEZ ..... El Paso
HOTEL TEXAS ..... Fort Worth
HOTEL BUCCANEER ..... Galveston
HOTEL JEAN LAFITTE ..... Galveston
CORONADO COURTS ..... Galveston
MIRAMAR COURT ..... Galveston
HOTEL CAVALIER ..... Galveston
HOTEL LUBBOCK ..... Lubbock
HOTEL FALLS ..... Marlin
HOTEL GHOLSON ..... Ranger
HOTEL CACTUS ..... San Angelo
ANGELES COURT ..... San Antonio

VIRGINIA

HOTEL MOUNTAIN LAKE ..... Mt. Lake

AFFILIATED NATIONAL HOTELS

E-8-225

W. H. Miner to Odessa for Lufkin

W. H. MINER

W. H. Miner, formerly sales engineer for the Hughes Tool Company at Hobbs, New Mexico, Midland, Texas, and Ada, Oklahoma, has been placed in charge of the Lufkin Foundry and Machine Company branch office and warehouse at Odessa, Texas.

After graduating from the school of Petroleum Engineering, University of Oklahoma, Miner was connected with the I.T.I.O. Company in the Oklahoma City field for two years, later going to the Hughes Tool Company as sales engineer. He has been connected with the Lufkin company in an engineering capacity since September, 1937.

Delivers Opening Address at Tulsa Oil Show

H. C. Merritt, vice-president and general manager of the Allis-Chalmers Manufacturing Company, Tractor Division, Milwaukee, Wisconsin, is shown delivering the opening address at the International Petroleum Exposition, Tulsa, Oklahoma. Elaborate ceremonies marked the opening of the Exposition, the speakers being W. G. Skelly, president of the Skelly Oil Company and head of the Exposition, A. E. Barit, president of the Hudson Motor Car Company, and Mr. Merritt, who made the principal address.

ARMSTRONG BROS. Dependable PIPE TOOLS

STRONGER at the KEY POINTS!

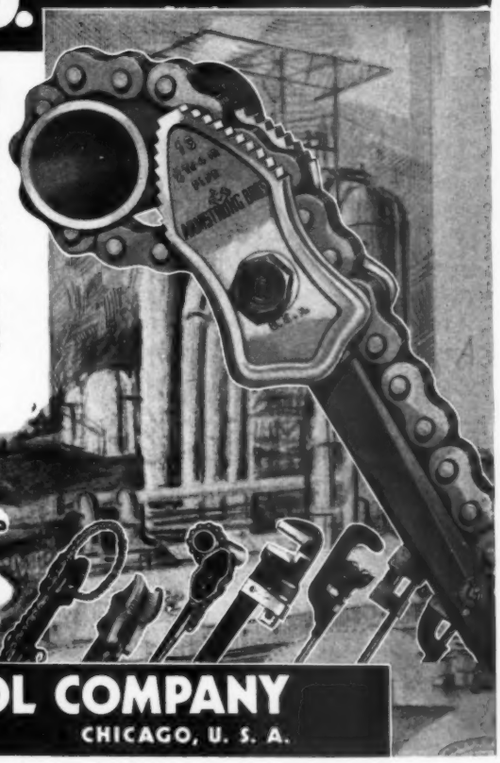
Each ARMSTRONG BROS. Pipe Tool is an improved tool . improved not only in design, balance and material but stronger at key points. Take the ARMSTRONG BROS. Chain Pipe Vise, for example: It has one-piece drop-forged (patented) jaws with a supporting center lug that prevents bending of the smallest pipe. The base is drop-forged, as is the handle. The screw is alloy steel. The chain is proof-tested. Combining maximum strength and capacity with minimum weight, this is the ideal pipe vise for outdoor work—goes into any tool bag, attaches to any post or bench.

Throughout the ARMSTRONG BROS. Line you will find drop-forged, hardened, and alloy steel parts wherever they will add to strength, wearing quality or tool life. It is in "tool sense" and "built-in" quality that they have earned the identifying description—"The Better Pipe Tools."

Write today for the ARMSTRONG *Catalog of the most complete line of Pipe Tools made.*

ARMSTRONG BROS. Chain Pipe Vise (Patented) 1-piece Jaw

ARMSTRONG BROS. TOOL COMPANY
"The Tool Holder People"
331 North Francisco Avenue, Chicago, U. S. A.
Eastern Warehouse and Sales: 199 Lafayette Street, New York
San Francisco London



ARMSTRONG BROS. TOOL COMPANY
331 N. FRANCISCO AVE. CHICAGO, U. S. A.

Quicker!
Cleaner!
Lower Cost
Pipe Cutting

with this remarkable RIDGID Wheel-Blade Cutter...

Because every RIDGID tool is designed to save you bother and expense old-fashioned tools cause you, the millions of them now in use have saved billions of hours that used to be wasted.

That's true of this cutter. The thin bladed wheel — coined out of tool steel, hammered, heat-treated and assembled in a solid hub — has the extra stamina to keep on rolling readily cleanly through all kinds of pipe long after ordinary cutter wheels need replacing. And the housing is guaranteed warp-proof — always cuts true, twirls easily to your pipe size.

Try this tool of the smart buyer and the expert user. Save yourself time and expense with the RIDGID Cutter that gives you far more cuts per wheel-blade. Buy from your Supply House — now.

THE RIDGE TOOL CO., ELYRIA, O.

No More Wrench Housing Repairs

That guarantee saves you fully 75% of your pipe wrench repairs. Buy the RIDGID.

RIDGID PIPE TOOLS

Trade Personals

M. P. LAURENT

M. P. LAURENT has resigned as chief engineer of the W-K-M Company, Houston, Texas, to devote his time to mechanical engineering consultation. Laurent's contributions to the oil industry include the W-K-M lubricated gate valve, the Unibolt coupling, the Unibolt flow bean and ball joint. The Unibolt equipment is manufactured by the Thornhill-Craver Company, Houston.

•

T. E. WARD, president, Oilfield Equipment, Inc., 30 Church Street, New York, was an interested visitor at the International Petroleum Exposition at Tulsa last month. He has visited each International Petroleum Exposition held in Tulsa to date.

•

L. J. MILDREN, inventor of the Mildren (Hinderliter) head or tubing support and at one time general superintendent of the Marland Oil Company is now resident in Tulsa, where he is connected with the Taylor Recondition Service.

•

D. L. KESSLER, engineer with the Gates Rubber Company, Denver, Colorado, is making a business trip through the Mid-Continent and Gulf Coast areas.

•

W. C. MORGAN has been appointed district sales manager in the Southwest territory for the Murphy Diesel Company, Ltd. His headquarters are Tulsa, Oklahoma. The W-K-M Company is agent in the Mid-Continent area for Murphy Diesel.

•

N. R. PUTNAM has been appointed a field representative at the Tulsa office of the Jones and Laughlin Steel Corporation, Pittsburgh, it is announced by L. M. Parsons, vice-president in charge of sales for the corporation. Engaged in the oil business since 1912, Putnam is well known throughout the oil fields of the southern and southwestern part of the country.

•

RUFUS E. ZIMMERMAN, vice-president of research and technology, United States Steel Corporation, received the degree of Doctor of Science from Franklin and Marshall College at its commencement exercises in Lancaster, Pennsylvania, June 1. Zimmerman was graduated from Franklin and Marshall in 1908 with a Ph.B. degree and later attended Massachusetts Institute of Technology receiving his S.B. degree in 1911.

•

Another Dividend by Houston Oil Show

A refund of 5 percent, which is in addition to a previous refund of 20 percent, was mailed to exhibitors in the 1937 Oil-World Exposition early in June. This is in accordance with the policy of the Exposition, which is a non-profit enterprise organized for educational purposes only.

Giant Wire Rope Slings

Completion of two new giant wire rope slings, each with a strength of 176.4 tons, and with a joint load carrying

New giant braided body wire rope slings made to special order by the Macwhyte Company. Jim Drew, designer of the slings, is seen at the extreme left

capacity when used in a basket hitch of more than 98 tons, has just been announced by the Macwhyte Company, Kenosha, Wisconsin.

"One of the features of these new 'Drew Slings' is their light weight and flexibility," according to Jim Drew, their designer. "They are made from an endless element of 1-in. wire rope, braided to form a flat 6-part body.

"The natural loop eyes at either end are formed by the endless wire rope. This patented construction makes the slings extremely easy to handle and load, and also gives them an unusually high safety factor."

The two slings were made to special order, but the name of the company to which they are being shipped was not disclosed.

●

Springtime

This springtime weather makes me wish
That I could plan some scheme,
Where I could camp and dream and fish
On some secluded stream.

If I could just forget the things
That try my jaded soul,
Like engines, valves, and piston rings,
For just a fisherman's role.

If I could load the old bus down
With tackle, grub, and bait,
And sneak away from the busy town
To the banks of some silvery lake.

There I'd pitch my tent in some shady nook
Where birds sing their song in the trees,
There I'd camp and fish, or read a good book
In the cool of a spring day breeze.

I'd forget about budgets and all such inventions
As cam shafts and flywheels that just seem to me
At this time of year, to divert my attentions
From the place where I know the fish ought to be.

W. E. Nestor,
Superintendent of Compressor Stations,
Arkansas-Louisiana Gas Company,
Shreveport, Louisiana.

A Hook that is truly Safe

B-M-W NEILSON

Safety Sucker Rod Hook

Ball Bearing Enclosed in Grease-Packed Bail

This rugged hook assures 100% safety because of its very simple and dependable latch arrangement combined with a free-swiveling and grease-packed bail. Two sizes for rods—one size for tubing. Circular on request.

Stocked By

Leading supply stores carry B-M-W Products in stock, including: ● ADMORE Insert Pump Anchors; ● NEILSON Tools (Safety Sucker Rod Hooks, Tubing Hooks, Rod Elevators, Sucker Rod Sockets, etc.); ● BALLS and SEATS (made for every pumping service); ● ADMORE Liner Barrels; ● TEX TYPE Plunger Fittings and Valves; and ● COLLINS Belt Clamps.

BRADFORD MOTOR WORKS INC.
OIL WELL SUPPLIES
BRADFORD, PA. — TULSA, OKLA.

COMFORT AND CONVENIENCE!

Now you may combine the advantages of a luxurious hotel with the convenience of living economically in the very heart of the city.

Air-Conditioned

Rooms, Apartments, Suites . . .
Coffee Shop and Meeting Rooms.

That Friendly Atmosphere!

Hotel TULSA

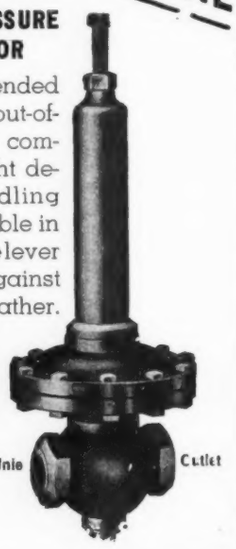
SAFEGUARDING PRESSURE

FULTON HIGH PRESSURE SPRING REGULATOR

Especially recommended for use in remote, out-of-the-way places. Its compact and light-weight design reduces handling and installation costs. Preferable in such places to a regulator of the lever type as it protects itself against tampering or injury by weather.

Equipped for high pressure, it reduces from 300 pounds to any desired pressure between 10 and 50 pounds.

Full information given in Bulletin 118.



Catalog on Request

THE CHAPLIN-FULTON MFG. CO.

28-40 Penn Ave. Pittsburgh, Pa.

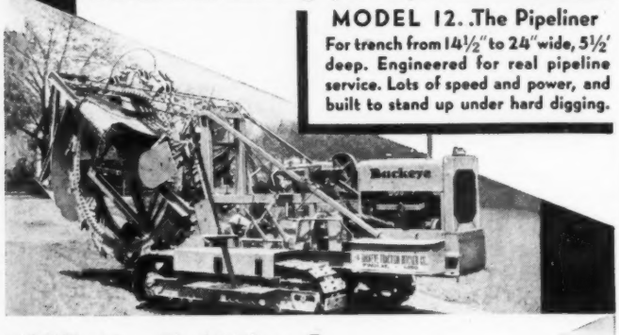
CF

Rely on Buckeye DITCHERS

The most important pipelines the world over are laid in trenches dug by Buckeye Ditchers.

MODEL 12. .The Pipeliner

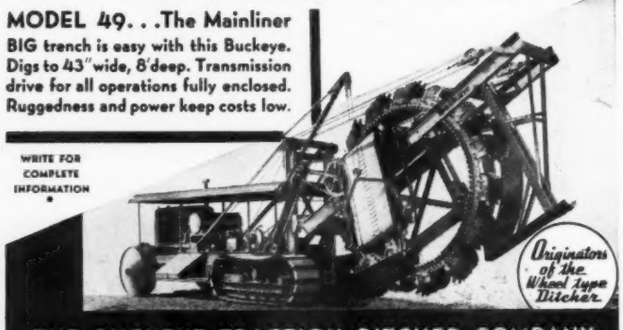
For trench from 14½" to 24" wide, 5½' deep. Engineered for real pipeline service. Lots of speed and power, and built to stand up under hard digging.



MODEL 49. . .The Mainliner

BIG trench is easy with this Buckeye. Digs to 43" wide, 8' deep. Transmission drive for all operations fully enclosed. Ruggedness and power keep costs low.

WRITE FOR COMPLETE INFORMATION



THE BUCKEYE TRACTION DITCHER COMPANY
FINDLAY, OHIO

Link-Belt Issues New Roller Chain Data Book

Announcement is made by Link-Belt Company, Indianapolis, Indiana, of the completion of a new data book, No. 1757, on its Silverlink roller chain and sprockets for drives and conveyor uses—a book of 174 pages of practical information, application pictures, and engineering data, including many new chains and features not hitherto published. This book covers Silverlink roller chains of manufacturers' (A. S. A.) standard sizes, non-standard sizes, and "heavy sizes." Included also are multiple-width roller drive chains, with ultimate strength ranging up to 460,000 pounds.

Page 29 covers a particularly outstanding chain, called Twist-Type, a Link-Belt engineering development not hitherto announced. This chain is provided with axial clearance to accommodate a normal amount of twisting action.

Notes, formulae, and tabular data are given on how to select the proper combination of chain and wheels for an efficient drive. These instructions are much simpler than those previously published. Twenty-two pages are devoted to tabulation and uses of Silverlink roller chain on conveyor work.

Several pages are devoted to the new two-plane Universal Carrier chain, which the company announced recently as an outstanding innovation in conveyor chain.

Included in the data book is the new Link-Belt line of stainless steel and bronze chains. Tables are presented to show the extent to which stainless steel chains will resist the many agents of corrosion listed. Much valuable information also is given with reference to the uses for bronze chain. This is Link-Belt's first publication of data on this subject.

A number of pages are devoted to "RCB" roller chain flexible couplings for connecting shafting in line. Then come many pages of tables of sprocket wheels regularly carried in stock by Link-Belt plants, warehouses and distributors, and of made-to-order wheels promptly available.

The concluding pages of the book contain power formulae for chain conveyors and elevators, horsepower tables, electrical data, much information on shafting, weights and measures, trigonometrical functions, etc.

A copy of the new book will be sent to anyone having occasion to select, order, use or maintain equipment of this character. The request should be made on business letterhead, and may be addressed to Link-Belt Company, 519 North Holmes Avenue, Indianapolis, Indiana, or to the nearest office of the company.

Lufkin Opens Wichita Falls Office

Harold Blodgett formerly associated with the Gulf Oil Corporation's West Texas production and drilling departments for four years, has opened the Wichita Falls office of the Lufkin Foundry and Machine Company as district representative. After graduation from A. & M. College of Texas in mechanical engineering, Blodgett had extensive training in actual field operations.

HAROLD BLODGETT

American Iron Opens Shop at Harvey, Louisiana

American Iron and Machine Works Company has opened a complete machine shop at Harvey, Louisiana. The new shop is equipped to handle oil-field equipment. Geo. S. Hinkle, former district manager for American at Houston, Texas, is supervisor of the new shop. Al Blackstrom is shop foreman.

●

New Building for Walter Ruska and Company

Walter Ruska and Company, Inc., manufacturer of scientific instruments, is erecting a new one-story shop and laboratory building at 2332 Bellaire Boulevard, Houston, Texas.

Of attractive, modernistic design, the structure will contain five times the floor space of the company's present building, with room provided for future expansion.

A total investment of approximately $35,000 will be represented in the lot, the building, and the equipment. Covering 40 ft. by 85 ft. the structure will be of brick, hollow tile, and concrete, with steel sash throughout. The plans also call for attic ventilation.

●

Lowe Reelected by N.G.A.A.

WILLIAM F. LOWE

At a recent meeting at the Tulsa Club, Tulsa, Oklahoma, the board of directors of the Natural Gasoline Association of America re-elected William F. Lowe as secretary-treasurer of the association. This will be the fifth term for Lowe in that office.

The association has just completed a particularly successful and busy year, according to J. A. LaFortune, Warren Petroleum Corporation, president of the association, and plans for the coming year indicate a continuation of that trend. Committee activities already scheduled are of widespread interest and will require considerable research work to bring the desired conclusions.

●

T. D. Davies, Formerly of National Tube, Passes Away

Thomas D. Davies, who resigned as assistant to the vice-president of the National Tube Company two years ago because of ill health, passed away at McKeesport, Pennsylvania, on May 28th. He had returned to McKeesport from Arizona about two weeks previously. Funeral services and interment were at McKeesport.

●

Consolidate Coast Business

The Allegheny Steel Company and the Ludlum Steel Company announce that effective immediately the Pacific Coast business of both companies will be consolidated under the supervision of James H. Spade, 1417 Santa Fe Avenue, Los Angeles, California.

HOUGH Seamless-Steel WORKing Barrels

(accent on work!)

Perhaps the most valuable feature of Hough Seamless-Steel Working Barrels is their *workability* . . . their ability to work for you, efficiently and economically. The *seamless* feature means longer life under severe conditions.

Hough Working Barrels are made to A.P.I. specifications from highly specialized cold-drawn tubing. All standard sizes; in stock at your oil-field distributor's.

THE CHARLES N. HOUGH MFG.CO.

Franklin, Pa., and Tulsa, Okla.

This IS *something new!*

SHULL HYDROSTATIC **SCAVENGER**

Recovers all the junk from the bottom of wells

Utilizing differential pressure in the well to pick up junk such as lost rock bit cores, pieces of tools, sucker rods, etc., the Shull Hydrostatic Scavenger will completely clean out the bottom of any well. Difference between pressure in the well and atmospheric pressure is the force which picks up junk and delivers it into the junk basket. Handles shapes no other tool can successfully fish.

The New Shull Catalog

tells all about it.

Request a copy.

SHULL PERFORATING CO., Inc.

2750 CHERRY AVENUE LONG BEACH, CALIF.

ENSIGN FILTER

for natural gas engines

Filters out all foreign matter in gas supply lines

Here is an important addition to the complete line of ENSIGN Natural Gas and Butane carburetion equipment. • Installed in the gas supply line, this newest ENSIGN development filters out all injurious foreign matter which might be present to cause trouble. Made in two sizes for installation in 1″ and 2″ vertical or horizontal pipe lines, the ENSIGN Natural Gas Filter is extremely simple, and the element is easily removed for cleaning or replacement. Full particulars on request.

ENSIGN CARBURETOR CO., LTD.

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Oakite Cleaning

SALVAGED

used equipment

DISCARDED, muck-covered valves, pipe, fittings, etc., may LOOK like Junk .. BUT .. it is just such equipment that more and more concerns are today salvaging the Oakite way .. and saving thousands of dollars.

Perhaps YOUR "junk pile" holds hidden treasure, too. Why not reclaim and recondition it? One oil company tells us Oakite materials helped reclaim over $20,000 worth of equipment.

Let us tell you how you can SOAK equipment clean .. without hand scraping or scrubbing .. and save money. Write today.

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OAKITE *Certified* **CLEANING**

MATERIALS & METHODS FOR EVERY CLEANING REQUIREMENT

Book Reviews

Modern Methods of Refining Lubricating Oils, by V. A. Kalichevsky. American Chemical Society Monograph No. 76, published by Reinhold Publishing Corporation, New York, N. Y. (1938) 235 pp. Price, $6.00.

The properties of refined oils, modern refining methods, petroleum waxes and their removal, asphaltic substances and their removal, solvents and methods of solvent refining; pour point depressants, viscosity index improvers, oiliness carriers, oxidation inhibitors, and fluorescence are concisely described and references to detailed discussions of each phase are included in the bibliography accompanying each chapter. Conversion tables, empirical equations for thermal properties of petroleum products, and a comparison of oxidation tests are included in an appendix. This volume should be particularly valuable to chemists in refineries preparing lubricating oils for any type of service.

* * *

Graphic Routes to Greater Profits, by J. W. Esterline. Published by The Esterline-Angus Company, Indianapolis, Indiana (1938), 320 pp. Price, $3.00.

The use of electrically-operated recording instruments for determining the efficiency of power transmission, distribution, and utilization, of machine operation, of manufacturing processes, and of workmen, and for the testing and demonstration of products is fully discussed, and illustrated by numerous examples. The many applications cited are not intended to exhaust the subject, but to indicate the principal methods and to suggest to the reader possible ways of increasing the usefulness of his own recording instruments.

The most instructive feature of the book, however, is the two-page foreword, in which the author contrasts the elimination of hopelessly faulty machinery and redesign of inefficient apparatus by industry with the pampering or disregard of human machines in similar condition by society.

* * *

Procedure Handbook of Arc Welding Design and Practice, (Fifth Edition). Published by The Lincoln Electric Company, Cleveland, Ohio. 1012 pp., 1243 illus. Binding of brown semi-flexible, simulated leather, gold embossed. Price, $1.50 in the United States; foreign, $2.00.

The Handbook is reissued each year to include all new data essential for most efficient use of arc-welding in all its varied applications. Encyclopedic in scope, concisely written and profusely illustrated, the Handbook is a most complete arc-welding reference guide. Written especially for use of designers, engineers, architects, production managers, welding supervisors, and operators, it contains a wealth of data of interest to draftsmen, steel fabricators and erectors, foremen, cost estimators, maintenance managers, shipbuilders, piping and pipe line contractors, and students of welding.

The eight sections of the book are headed as follows:

Part I—Welding Methods and Equipment.

Part II—Technique of Welding.

Part III—Procedures, Speeds and Costs of Welding Mild Steel.

Part IV—Structure and Properties of Weld Metal.

Part V—Weldability of Metals.

Part VI—Designing for Arc-Welded Steel Construction of Machinery.

Part VII—Designing for Arc-Welded Structures.

Part VIII—Typical Applications of Arc-Welding in Manufacturing, Construction and Maintenance.

TRADE LITERATURE

HANLON-WATER, INC., Tulsa, Oklahoma, has issued a new bulletin, No. 12, illustrating and describing the Hanlon-Waters Type No. 2000 boiler fuel control unit for oilfield boilers.

●

THE CLEVELAND TRENCHER COMPANY, Cleveland, Ohio, has just published a folder on its Model 90 pipe line backfiller and pipe layer. The equipment is described fully and pictures are included that show actual field operations.

●

A COMPREHENSIVE and well-illustrated booklet has been issued by Chain Belt Company, Milwaukee, Wisconsin, which is a data book on oilfield chains. Pertinent information concerning Rex chains is given. Copies are being sent free to interested persons.

●

A NEW CATALOG issued by S. R. Dresser Manufacturing Company, Bradford, Pennsylvania, is entitled "How to Join and Repair Pipe the Quick, Easy, Permanent Way." This 12-page, 8½ by 11, booklet gives operating men helpful information on how to construct and maintain pipe lines. Dresser pipe couplings for the joining of new lines, and Dresser repair clamps and repair sleeves for the repair of old lines, are fully described. "Before and after" pictures tell at a glance the function of the product.

●

THE CONTINENTAL SUPPLY COMPANY, Dallas, Texas, has recently published several bulletins describing its latest equipment. Included is a special series devoted to information on geared pumping units, as follows:

JEM and KEM Electro-Mechanical Rotary Rig.
Fairbanks-Morse Type "Z" Oil Well Pumping Engines.
Climax "Blue Streak" Oil Well Pumping Engines.
Continental-Falk HT, HTA, and HTD Geared Pumping Units.
Continental-Falk KT, KTA, KBT, and KBTA Geared Pumping Units.
Continental-Falk LT and LTA Geared Pumping Units.
Roper Rotary Pump Units.
Copies of the bulletins are available upon request.

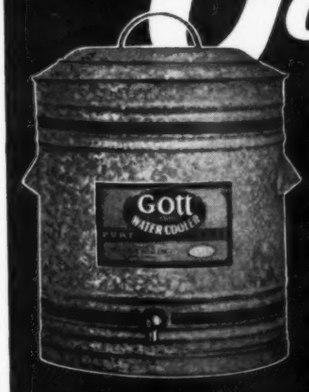
●

THE BROWN INSTRUMENT COMPANY has published a new folder entitled "Legibility Plus Precision." This folder reproduces the colored numeral records exactly as they are printed on the chart of the Brown Potentiometer Pyrometer Recorders. It explains the significance of the Brown (+) Symbol, which is a part of each numeral record. Copies of this folder will be sent upon request. Address The Brown Instrument Company, Wayne and Roberts Avenues, Philadelphia, Pennsylvania, and ask for folder No. 84-9.

●

CATALOG 617, recently published by the Diamond Chain and Manufacturing Company, Indianapolis, Indiana, contains 96 pages of information on the use of roller chains for motor drives, machinery, and conveyor applications. The engineering section includes new and additional data, tables, formulae, and selection and installation information. Other sections cover dimensions and capacity tables for roller chain, chain attachments as used for conveying and timing mechanisms, non-corrosive chains, and sprockets.

Gotkool
WATER CANS & COOLERS



GOTT Water Coolers are the convenient way to keep drinking water handy to the worker, protect it from impurities. Their exclusive construction keeps water cool for long periods. Snug fitting large removable top, handy non-leaking push button faucet. GOTT Water Cans for handy field use. Your Supply Store has them, get one today!

GOTT WATER COOLER
Made in 2, 5, 8, 10, and 20 gallon sizes.

GOTT WATER CAN
Made in 1½, 3, 5, and 10 gallon sizes.

H. P. GOTT MFG. CO.
WINFIELD, KANSAS

KEEP PURE DRINKING WATER ALWAYS HANDY

GAS MIXING VALVES
★
BUTANE VAPORIZING EQUIPMENT
Built to comply with published regulations of the National Fire Protection Association.
WRITE FOR DESCRIPTIVE BULLETIN
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Keep Your File Complete on

THE PETROLEUM ENGINEER'S "CONTINUOUS TABLES"

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MORE MILLER'S ARE USED IN CLEANING-OUT THAN ALL OTHER SAND PUMPS MADE

The Reason

IS BUILT INTO

The MILLER

• The RESULT is oil in your tanks in place of sand in your Well. Get FULL production from your wells, CLEAN-OUT with a MILLER.

The Miller is made in diameters of 2½, 3, 3½, 4, 4¼, 5, 5½, 7 and 9 inches and lengths of 20, 25 and 30 feet. 5/32-inch wall thickness in REGULAR Type, ¼-inch wall tubes HEAVY Type Sand Pumps.

INTERCHANGEABLE BOTTOMS

To Meet Every Condition

● BAILER BOTTOM

With the Bailer Bottom installed the MILLER is quickly changed to a Bailer giving you a combination of either Bailer or a Sand Pump in one tool.

● SAND BOTTOM

Used when tools are run and when well is shot to quickly remove loose material.

● STAR BOTTOM

Used for cutting the sand loose.

● CHISEL BOTTOM

(In Pump)

With this bottom tightly packed sand can be easily broken in small pieces so it can be picked up in the pump.

Write for Descriptive Folder and Price List

See Page 1445 COMPOSITE CATALOG

PATENTED NO. 1370340 NO. 1523908 NO. 1787890 NO. 1962685 NO. 1966028 NO. 2056057

MILLER

Sand Pump Co.

General Offices and Shop, Box 4516

OKLAHOMA CITY, OKLA., U. S. A.

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FOR SALE BY SUPPLY STORES EVERYWHERE

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THE *Petroleum* Engineer's CONTINUOUS TABLES

A DAILY REFERENCE FOR OPERATING MEN

INSTALLMENT NO. 13

THE tables on the following pages are designed to save time and effort for the technician, and to assist the practical field or plant worker to solve problems commonly encountered in routine work. They are not intended nor expected to supplant technical training and make every man his own designer. Most of the tables can be understood and applied by anyone acquainted with the simple fundamentals of mathematics.

For the convenience of readers who wish to refer to the tables, each page carries in the upper right corner an index number that classifies the table according to subject matter.

All petroleum engineering literature may be indexed for reference according to the Dewey Decimal System as modified and extended for the petroleum industry by L. C. Uren, professor of petroleum engineering at the University of California. When classified according to these index numbers the material follows in a logical sequence and falls into several natural divisions, as illustrated by the following outline:

Nos. P000-P399—General
Nos. P400-P499—Drilling
Nos. P500-P599—Production
Nos. P600-P699—Transportation and Storage (includes Pipe Line)
Nos. P700-P799—Refining, including
Nos. P770-P799—Natural Gasoline, which may be classified in a separate division (as shown here) if of special interest to the user.

Engineering Data Especially Compiled for Office, Field, and Plant Use

A REGULAR FEATURE OF THE PETROLEUM ENGINEER

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WEIGHT AND VOLUME OF 4½-IN. DRILL PIPE

Length of string of drill pipe, ft.	12.75 lb. drill pipe				13.75 lb. drill pipe				16.60 lb. drill pipe			
	Weight, coupled,[1] lb.	Volume of fluid displaced, gal.	Weight of 9.5 lb./gal. fluid displaced, lb.	Net weight of drill pipe, lb.	Weight, coupled,[1] lb.	Volume of fluid displaced, gal.	Weight of 9.5 lb./gal. fluid displaced, lb.	Net weight of drill pipe, lb.	Weight, coupled,[1] lb.	Volume of fluid displaced, gal.	Weight of 9.5 lb./gal. fluid displaced, lb.	Net weight of drill pipe, lb.
2,000	25,500	389.6	3,700	21,800	27,500	420.2	3,990	23,510	33,200	507.4	4,820	28,380
2,200	28,050	428.6	4,070	23,980	30,250	462.2	4,390	25,860	36,520	558.1	5,300	31,220
2,400	30,600	467.5	4,440	26,160	33,000	504.2	4,790	28,210	39,840	608.9	5,785	34,055
2,600	33,150	506.5	4,810	28,340	35,750	546.3	5,190	30,560	43,160	659.6	6,265	36,895
2,800	35,700	545.4	5,180	30,520	38,500	588.3	5,590	32,910	46,480	710.4	6,750	39,730
3,000	38,250	584.4	5,550	32,700	41,250	630.3	5,990	35,260	49,800	761.1	7,230	42,570
3,200	40,800	623.4	5,920	34,880	44,000	672.3	6,385	37,615	53,120	811.8	7,710	45,410
3,400	43,350	662.3	6,290	37,060	46,750	714.3	6,785	39,965	56,440	862.6	8,195	48,245
3,600	45,900	701.3	6,660	39,240	49,500	756.4	7,185	42 315	59 760	913.3	8,675	51,085
3,800	48,450	740.2	7,030	41,420	52,250	798.4	7,585	44,665	63,080	964.1	9,160	53,920
4,000	51,000	779.2	7,400	43,600	55,000	840.4	7,985	47,015	66,400	1014.8	9,640	56,760
4,200	53,550	818.2	7,775	45,775	57,750	882.4	8,385	49,365	69,720	1065.5	10,125	59,595
4,400	56,100	857.1	8,145	47,955	60,500	924.4	8,780	51,720	73,040	1116.3	10,605	62,435
4,600	58,650	896.1	8,515	50,135	63,250	966.5	9,180	54,070	76,360	1167.0	11,085	65,275
4,800	61,200	935.0	8,885	52,315	66,000	1008.5	9,580	56,420	79,680	1217.8	11,570	68,110
5,000	63,750	974.0	9,255	54,495	68,750	1050.5	9,980	58,770	83,000	1268.5	12,050	70,950
5,200	66,300	1013.0	9,625	56,675	71,500	1092.5	10,380	61,120	86,320	1319.2	12,535	73,785
5,400	68,850	1051.9	9,995	58,855	74,250	1134.5	10,780	63,470	89,640	1370.0	13,015	76,625
5,600	71,400	1090.9	10,365	61,035	77,000	1176.6	11,175	65,825	92,960	1420.7	13,495	79,465
5,800	73,950	1129.8	10,735	63,215	79,750	1218.6	11,575	68,175	96,280	1471.5	13,980	82,300
6,000	76,500	1168.8	11,105	65,395	82,500	1260.6	11,975	70,525	99,600	1522.2	14,460	85,140
6,200	79,050	1207.8	11,475	67,575	85,250	1302.6	12,375	72,875	102,920	1572.9	14,945	87,975
6,400	81,600	1246.7	11,845	69,755	88,000	1344.6	12,775	75,225	106,240	1623.7	15,425	90,815
6,600	84,150	1285.7	12,215	71,935	90,750	1386.7	13,175	77,575	109,560	1674.4	15,905	93,655
6,800	86.700	1324.6	12,585	74,115	93,500	1428.7	13,570	79,930	112,880	1725.2	16,390	96,490
7,000	89,250	1363.6	12,955	76,295	96,250	1470.7	13,970	82,280	116,200	1775.9	16,870	99,330
7,200	91,800	1402.6	13,325	78,475	99,000	1512.7	14,370	84,630	119,520	1826.6	17,355	102,165
7,400	94,350	1441.5	13,695	80,655	101,750	1554.7	14,770	86,980	122,840	1877.4	17,835	105,005
7,600	96,900	1480.5	14,065	82,835	104,500	1596.8	15,170	89,330	126,160	1928.1	18,315	107,845
7,800	99,450	1519.4	14,435	85,015	107,250	1638.8	15,570	91,680	129,480	1978.9	18,800	110,680
8,000	102,000	1558.4	14,805	87,195	110,000	1680.8	15,970	94,030	132,800	2029.6	19,280	113,520
8,200	104,550	1597.4	15,175	89,375	112,750	1722.8	16,365	96,385	136,120	2080.3	19,765	116,355
8,400	107,100	1636.3	15,545	91,555	115,500	1764.8	16,765	98,735	139,440	2131.1	20,245	119,195
8,600	109,650	1675.3	15,915	93,735	118,250	1806.9	17,165	101,085	142,760	2181.8	20,725	122,035
8,800	112,200	1714.2	16,285	95,915	121,000	1848.9	17,565	103,435	146,080	2232.6	21,210	124,870
9,000	114,750	1753.2	16,655	98,095	123,750	1890.9	17,965	105,785	149,400	2283.3	21,690	127,710
9,200	117,300	1792.2	17,025	100,275	126,500	1932.9	18,365	108,135	152,720	2334.0	22,175	130,545
9,400	119,850	1831.1	17,395	102,455	129,250	1974.9	18,760	110,490	156,040	2384.8	22,655	133,385
9,600	122,400	1870.1	17,765	104,635	132,000	2017.0	19,160	112,840	159,360	2435.5	23,135	136,225
9,800	124,950	1909.0	18,135	106,815	134,750	2059.0	19 560	115,190	162,680	2486.3	23,620	139,060
10,000	127,500	1948.0	18,505	108 995	137,500	2101.0	19,960	117,540	166,000	2537.0	24,100	141,900
10,200	130,050	1987.0	18,875	111,175	140,250	2143.0	20,360	119,890	169,320	2587.7	24,585	144,735
10,400	132,600	2025.9	19,245	113,355	143,000	2185.0	20,760	122,240	172,640	2638.5	25,065	147,575
10,600	135,150	2064.9	19,615	115,535	145,750	2227.1	21,155	124,595	175,960	2689.2	25,550	150,410
10,800	137,700	2103.8	19,985	117,715	148,500	2269.1	21,555	126,945	179,280	2740.0	26,030	153,250
11,000	140,250	2142.8	20,355	119,895	151,250	2311.1	21,955	129,295	182,600	2790.7	26,510	156,090
11,200	142,800	2181.8	20,725	122,075	154,000	2353.1	22,355	131,645	185,920	2841.4	26,995	158,925
11,400	145,350	2220.7	21,095	124,255	156 750	2395.1	22,755	133,995	189,240	2892.2	27,475	161,765
11,600	147,900	2259.7	21,465	126,435	159,500	2437.2	23,155	136,345	192,560	2942.9	27,960	164,600
11,800	150,450	2298.6	21,835	128,615	162,250	2479.2	23,550	138,700	195,880	2993.7	28,440	167,440
12,000	153,000	2337.6	22,205	130,795	165,000	2521.2	23,950	141,050	199,200	3044.4	28,920	170,280
12,200	155,550	2376.6	22,575	132,975	167,750	2563.2	24,350	143,400	202 520	3095.1	29,405	173,115
12,400	158,100	2415.5	22,945	135,155	170,500	2605.2	24,750	145,750	205,840	3145.9	29,885	175,955
12,600	160,650	2454.5	23,320	137,330	173,250	2647.3	25,150	148,100	209,160	3196.6	30,370	178,790
12,800	163,200	2493.4	23,690	139,510	176,000	2689.3	25,550	150,450	212,480	3247.4	30,850	181,630
13,000	165,750	2532.4	24,060	141,690	178,750	2731.3	25,945	152,805	215,800	3298.1	31,330	184,470

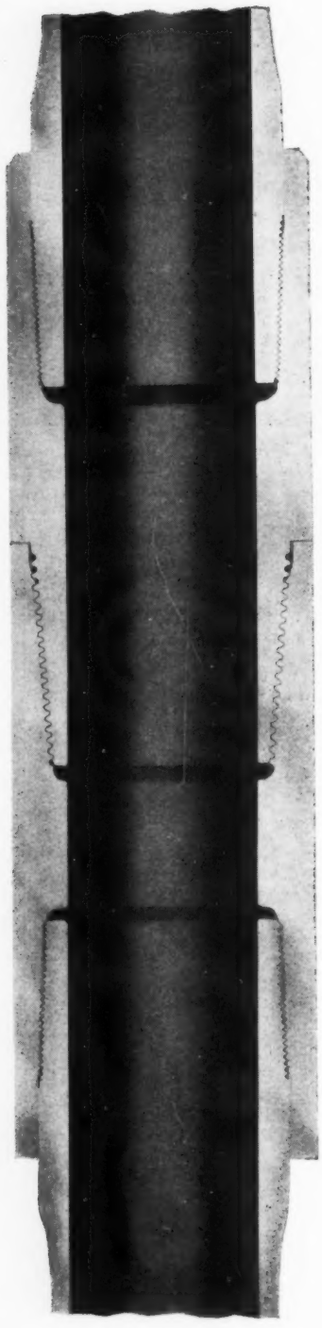
[1]If a regular tool joint is inserted every 90 ft. all values for 12.75-lb. drill pipe will be increased about 2.8 percent, for 13.75-lb. drill pipe about 2.5 percent, and for 16.60-lb. drill pipe about 1.9 percent.

The

REED

INTERNAL FLUSH

TOOL JOINT



UNRESTRICTED
MUD FLOW
WITH
DECREASED
PUMP PRESSURES
MEAN
GREATER SAVINGS
IN
RIG OPERATING
COSTS

REED ROLLER BIT COMPANY

P. O. DRAWER 2119, HOUSTON, TEXAS

LOS ANGELES, CALIFORNIA OKLAHOMA CITY, OKLAHOMA NEW YORK CITY

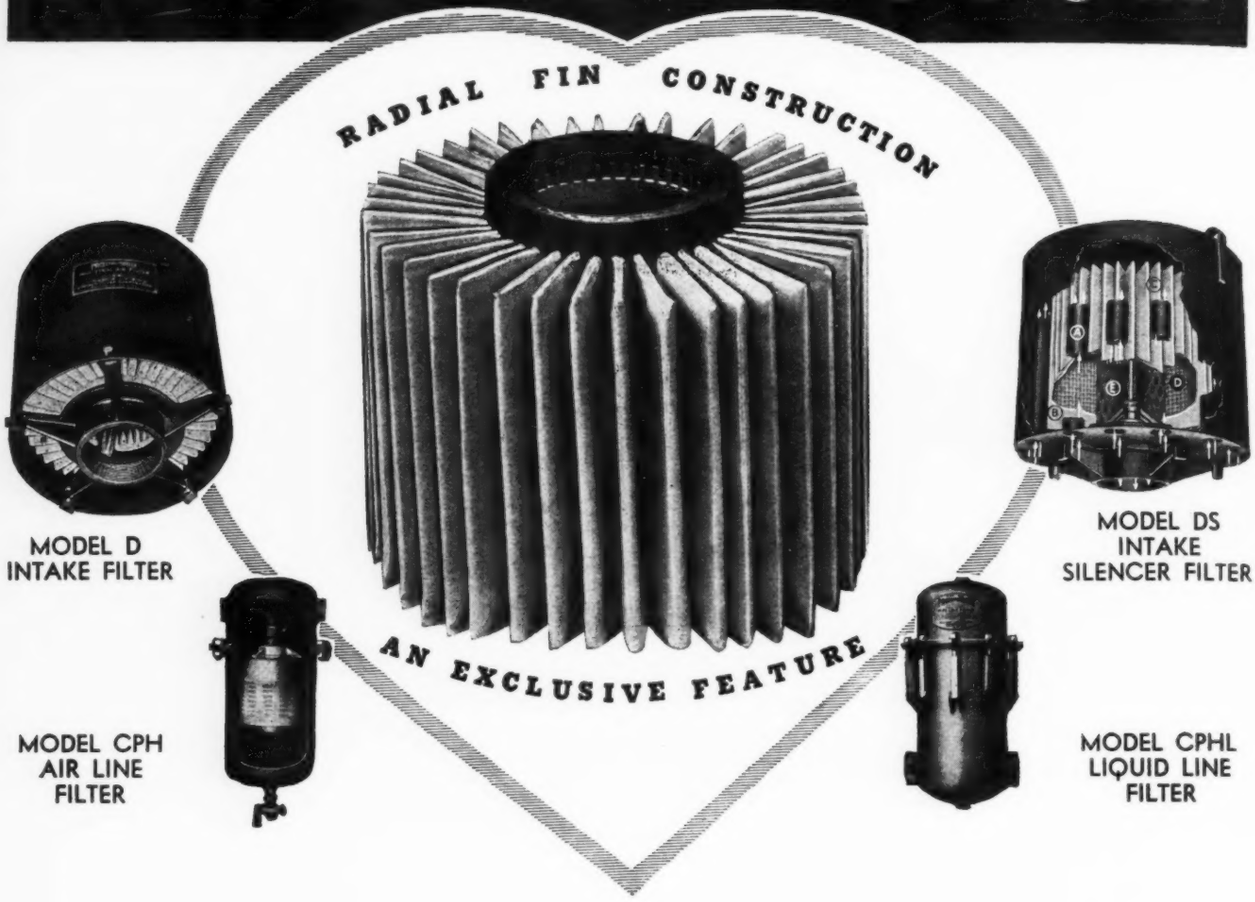
Mid-Continent, Gulf Coast and Rocky Mountain Distributors for MARTIN-DECKER Products.

PRESSURE DROP, LB. PER SQ. IN. PER MILE OF 8-IN.[1] PIPE LINE (OIL OF 30° A.P.I.)

Quantity of 30° A.P.I. oil, bbl. per hr.	Viscosity of oil, Saybolt Universal seconds										
	100	110	120	130	140	150	160	180	200	220	240
350	4.92	5.07	5.20	5.32	5.43	5.54	5.64	5.83	6.00	6.17	6.32
360	5.17	5.33	5.46	5.58	5.70	5.81	5.93	6.12	6.30	6.48	6.64
370	5.42	5.59	5.73	5.86	5.98	6.10	6.22	6.42	6.61	6.79	6.96
380	5.68	5.85	6.01	6.14	6.26	6.39	6.51	6.73	6.93	7.11	7.29
390	5.94	6.12	6.29	6.43	6.55	6.68	6.81	7.04	7.25	7.44	7.62
400	6.21	6.40	6.57	6.72	6.85	6.98	7.12	7.36	7.58	7.78	7.96
410	6.49	6.67	6.85	7.01	7.16	7.29	7.43	7.68	7.91	8.12	8.31
420	6.76	6.95	7.15	7.31	7.47	7.61	7.75	8.01	8.25	8.46	8.66
430	7.05	7.24	7.45	7.62	7.78	7.93	8.07	8.34	8.60	8.81	9.02
440	7.33	7.54	7.75	7.93	8.10	8.26	8.40	8.68	8.94	9.17	9.39
450	7.62	7.84	8.05	8.24	8.42	8.58	8.73	9.02	9.29	9.54	9.76
460	7.91	8.15	8.36	8.56	8.74	8.91	9.07	9.37	9.65	9.91	10.14
470	8.21	8.46	8.68	8.89	9.08	9.26	9.43	9.73	10.02	10.28	10.53
480	8.52	8.77	9.00	9.22	9.42	9.60	9.77	10.09	10.39	10.67	10.92
490	8.84	9.09	9.33	9.55	9.77	9.96	10.14	10.46	10.77	11.06	11.33
500	9.15	9.42	9.66	9.90	10.12	10.31	10.50	10.84	11.15	11.46	11.73
510	9.47	9.75	10.01	10.24	10.47	10.68	10.87	11.22	11.55	11.85	12.15
520	9.80	10.09	10.36	10.59	10.83	11.04	11.24	11.61	11.95	12.26	12.57
530	10.14	10.43	10.70	10.95	11.19	11.42	11.61	12.00	12.35	12.66	12.99
540	10.47	10.77	11.05	11.31	11.55	11.79	11.99	12.40	12.75	13.07	13.40
550	10.80	11.11	11.41	11.68	11.91	12.16	12.39	12.80	13.16	13.50	13.83
560	11.15	11.46	11.77	12.05	12.30	12.55	12.79	13.21	13.58	13.93	14.28
570	11.49	11.81	12.14	12.43	12.68	12.94	13.19	13.62	14.00	14.36	14.71
580	11.85	12.19	12.51	12.81	13.07	13.34	13.59	14.04	14.44	14.81	15.16
590	12.20	12.56	12.88	13.19	13.48	13.74	14.00	14.46	14.88	15.25	15.63
600	12.57	12.93	13.27	13.58	13.88	14.15	14.42	14.89	15.33	15.71	16.09
610	12.93	13.31	13.67	13.97	14.28	14.56	14.84	15.33	15.78	16.18	16.56
620	13.30	13.70	14.05	14.38	14.70	14.98	15.26	15.77	16.23	16.64	17.03
630	13.66	14.09	14.45	14.79	15.11	15.40	15.69	16.22	16.69	17.12	17.51
640	14.02	14.47	14.85	15.18	15.52	15.81	16.10	16.67	17.14	17.58	17.99
650	14.40	14.87	15.26	15.60	15.95	16.25	16.55	17.13	17.61	18.07	18.48
660	14.78	15.27	15.67	16.03	16.37	16.69	17.01	17.58	18.09	18.56	18.98
670	15.17	15.67	16.08	16.45	16.80	17.14	17.44	18.04	18.56	19.06	19.48
680	15.56	16.07	16.50	16.88	17.24	17.59	17.90	18.51	19.04	19.55	20.00
690	15.98	16.48	16.93	17.32	17.69	18.05	18.37	18.98	19.54	20.07	20.51
700	16.37	16.90	17.35	17.75	18.14	18.50	18.84	19.46	20.04	20.57	21.04
710	16.79	17.31	17.80	18.21	18.59	18.97	19.31	19.94	20.55	21.09	21.57
720	17.19	17.73	18.25	18.65	19.06	19.43	19.78	20.43	21.06	21.59	22.11
730	17.62	18.15	18.68	19.12	19.52	19.90	20.26	20.93	21.57	22.12	22.66
740	18.02	18.56	19.11	19.56	19.97	20.38	20.73	21.41	22.08	22.64	23.19
750	18.45	18.99	19.55	20.01	20.43	20.85	21.22	21.94	22.60	23.18	23.74
760	18.86	19.44	20.00	20.49	20.92	21.33	21.70	22.45	23.13	23.72	24.30
770	19.30	19.89	20.44	20.97	21.41	21.84	22.20	22.96	23.65	24.27	24.86
780	19.74	20.35	20.89	21.45	21.89	22.32	22.71	23.49	24.19	24.84	25.42
790	20.18	20.81	21.36	21.94	22.39	22.81	23.21	24.01	24.72	25.39	25.99
800	20.63	21.25	21.84	22.41	22.89	23.32	23.73	24.56	25.26	25.95	26.56
810	21.08	21.71	22.30	22.88	23.40	23.84	24.26	25.11	25.81	26.51	27.14
820	21.53	22.18	22.78	23.36	23.91	24.36	24.80	25.64	26.35	27.10	27.72
830	22.02	22.65	23.27	23.83	24.42	24.89	25.33	26.17	26.93	27.67	28.33
840	22.46	23.12	23.74	24.32	24.93	25.41	25.83	26.71	27.49	28.22	28.90
850	22.92	23.59	24.24	24.83	25.45	25.94	26.37	27.28	28.05	28.82	29.52
860	23.39	24.08	24.73	25.34	25.95	26.47	26.92	27.82	28.64	29.40	30.10
870	23.86	24.56	25.26	25.85	26.47	27.01	27.47	28.39	29.23	29.98	30.74
880	24.33	25.04	25.76	26.37	27.01	27.56	28.03	28.97	29.82	30.57	31.37
890	24.80	25.56	26.27	26.89	27.54	28.10	28.58	29.54	30.42	31.18	32.00
900	25.30	26.08	26.78	27.41	28.08	28.65	29.14	30.13	31.02	31.80	32.61
910	25.78	26.58	27.29	27.94	28.62	29.21	29.74	30.71	31.63	32.43	33.22
920	26.26	27.08	27.80	28.47	29.16	29.76	30.31	31.30	32.21	33.05	33.87
930	26.74	27.61	28.32	29.03	29.71	30.32	30.88	31.90	32.82	33.69	34.49
940	27.22	28.10	28.85	29.55	30.24	30.87	31.44	32.48	33.42	34.30	35.12
950	27.74	28.60	29.38	30.12	30.79	31.44	32.01	33.08	34.04	34.94	35.78
960	28.23	29.15	29.90	30.66	31.35	32.00	32.60	33.68	34.67	35.59	36.41
970	28.75	29.66	30.43	31.20	31.90	32.58	33.21	34.29	35.29	36.23	37.07
980	29.24	30.20	30.99	31.78	32.46	33.15	33.80	34.89	35.92	36.88	37.74
990	29.78	30.72	31.56	32.33	33.03	33.73	34.43	35.54	36.59	37.57	38.41
1000	30.31	31.27	32.13	32.91	33.63	34.34	35.02	36.16	37.23	38.23	39.12

[1]25.55 lb. per ft. For 29.35-lb. line pipe the pressure drop is approximately 5.4% greater.

THE HEART OF EVERY PROTECTOMOTOR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MODEL CPHL LIQUID LINE FILTER

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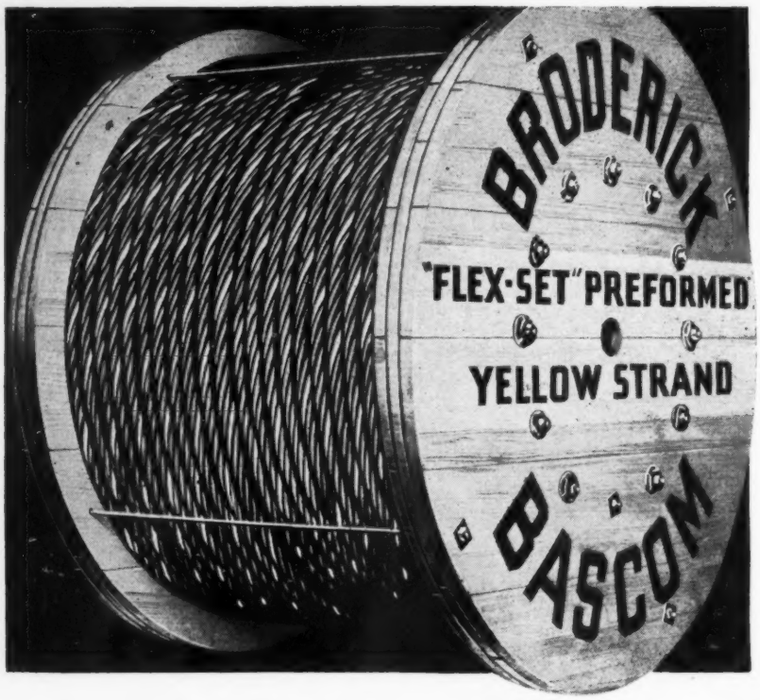
WEIGHT AND VOLUME OF 5 9/16-IN. DRILL PIPE

Length of string of drill pipe, ft.	19.00 lb. drill pipe				22.20 lb. drill pipe				25.25 lb. drill pipe			
	Weight, coupled,[1] lb.	Volume of fluid displaced, gal.	Weight of 9.5 lb./gal. fluid displaced, lb.	Net weight of drill pipe, lb.	Weight, coupled,[1] lb.	Volume of fluid displaced, gal.	Weight of 9.5 lb./gal. fluid displaced, lb.	Net weight of drill pipe, lb.	Weight, coupled,[1] lb.	Volume of fluid displaced, gal.	Weight of 9.5 lb./gal. fluid displaced, lb.	Net weight of drill pipe, lb.
2,000	38,000	580.6	5,515	32,485	44,400	678.4	6,445	37,955	50,500	771.6	7,330	43,170
2,200	41,800	638.7	6,065	35,735	48,840	746.2	7,090	41,750	55,550	848.8	8,065	47,485
2,400	45,600	696.7	6,620	38,980	53,280	814.1	7,735	45,545	60,600	925.9	8,795	51,805
2,600	49,400	754.8	7,170	42,230	57,720	881.9	8,380	49,340	65,650	1003.1	9,530	56,120
2,800	53,200	812.8	7,720	45,480	62,160	949.8	9,025	53,135	70,700	1080.2	10,260	60,440
3,000	57,000	870.9	8,275	48,725	66,600	1017.6	9,665	56,935	75,750	1157.4	10,995	64,755
3,200	60,800	929.0	8,825	51,975	71,040	1085.4	10,310	60,730	80,800	1234.6	11,730	69,070
3,400	64,600	987.0	9,375	55,225	75,480	1153.3	10,955	64,525	85,850	1311.7	12,460	73,390
3,600	68,400	1045.1	9,930	58,470	79,920	1221.1	11,600	68,320	90,900	1388.9	13,195	77,705
3,800	72,200	1103.1	10,480	61,720	84,360	1289.0	12,245	72,115	95,950	1466.0	13,925	82,025
4,000	76,000	1161.2	11,030	64,970	88,800	1356.8	12,890	75,910	101,000	1543.2	14,660	86,340
4,200	79 800	1219.3	11,585	68,215	93,240	1424.6	13,535	79,705	106,050	1620.4	15,395	90,655
4,400	83,600	1277.3	12,135	71,465	97,680	1492.5	14,180	83,500	111,100	1697.5	16,125	94,975
4,600	87,400	1335.4	12,685	74,715	102,120	1560.3	14,825	87,295	116,150	1774 7	16,860	99,290
4,800	91,200	1393.4	13,240	77,960	106,560	1628.2	15,470	91,090	121,200	1851.8	17,590	103,610
5,000	95,000	1451.5	13,790	81,210	111,000	1696.0	16,110	94,890	126,250	1929.0	18,325	107,925
5,200	98,800	1509.6	14,340	84,460	115,440	1763.8	16,755	98,685	131,300	2006.2	19,060	112,240
5,400	102,600	1567.6	14,890	87,710	119,880	1831.7	17,400	102,480	136,350	2083.3	19,790	116,560
5,600	106,400	1625.7	15,445	90,955	124,320	1899.5	18,045	106,275	141,400	2160.5	20,525	120,875
5,800	110,200	1683.7	15,995	94,205	128,760	1967.4	18,690	110,070	146,450	2237.6	21,260	125,190
6,000	114,000	1741.8	16,545	97,455	133,200	2035.2	19,335	113,865	151,500	2314.8	21,990	129,510
6,200	117,800	1799.9	17,100	100,700	137,640	2103.0	19,980	117,660	156,550	2392.0	22,725	133,825
6,400	121,600	1857.9	17,650	103,950	142,080	2170.9	20,625	121,455	161,600	2469.1	23,455	138,145
6,600	125,400	1916.0	18,200	107,200	146,520	2238.7	21,270	125,250	166,650	2546.3	24,190	142,460
6,800	129,200	1974.0	18,755	110,445	150,960	2306.6	21,910	129,050	171,700	2623.4	24,925	146,775
7,000	133,000	2032.1	19,305	113,695	155,400	2374.4	22,555	132,845	176,750	2700.6	25,655	151,095
7,200	136,800	2090.2	19,855	116,945	159,840	2442.2	23,200	136,640	181,800	2777.8	26,390	155,410
7,400	140,600	2148.2	20,410	120,190	164,280	2510.1	23,845	140,435	186,850	2854.9	27,120	159,730
7,600	144,400	2206.3	20,960	123,440	168,720	2577.9	24,490	144,230	191,900	2932.1	27,855	164,045
7,800	148,200	2264.3	21,510	126,690	173,160	2645.8	25,135	148,025	196,950	3009.2	28,590	168,360
8,000	152,000	2322.4	22,065	129,935	177,600	2713.6	25,780	151,820	202,000	3086.4	29,320	172,680
8,200	155,800	2380.5	22,615	133,185	182,040	2781.4	26,425	155,615	207,050	3163.6	30,055	176,995
8,400	159,600	2438.5	23,165	136,435	186,480	2849.3	27,070	159,410	212,100	3240.7	30,785	181,315
8,600	163,400	2496.6	23,720	139,680	190,920	2917.1	27,715	163,205	217,150	3317.9	31,520	185,630
8,800	167,200	2554.6	24,270	142,930	195,360	2985.0	28,355	167,005	222,200	3395.0	32,255	189,945
9,000	171,000	2612.7	24,820	146,180	199,800	3052.8	29,000	170,800	227,250	3472.2	32,985	194,265
9,200	174,800	2670.8	25,370	149,430	204,240	3120.6	29,645	174,595	232,300	3549.4	33,720	198,580
9,400	178,600	2728.8	25,925	152,675	208,680	3188.5	30,290	178,390	237,350	3626.5	34,450	202,900
9,600	182,400	2786.9	26,475	155,925	213,120	3256.3	30,935	182,185	242,400	3703.7	35,185	207,215
9,800	186,200	2844.9	27,025	159,175	217,560	3324.2	31,580	185,980	247,450	3780.8	35,920	211,530
10,000	190,000	2903.0	27,580	162,420	222.000	3392.0	32,225	189,775	252,500	3858.0	36,650	215,850
10,200	193,800	2961.1	28,130	165,670	226,440	3459.8	32,870	193,570	257,550	3935.2	37,385	220,165
10,400	197,600	3019.1	28,680	168,920	230,880	3527.7	33,515	197,365	262,600	4012.3	38,115	224,485
10,600	201,400	3077.2	29,235	172,165	235,320	3595.5	34,155	201,165	267,650	4089.5	38,850	228,800
10,800	205,200	3135.2	29,785	175,415	239,760	3663.4	34,800	204,960	272,700	4166.6	39,585	233,115
11,000	209,000	3193.3	30,335	178,665	244,200	3731.2	35,445	208,755	277,750	4243.8	40,315	237,435
11,200	212,800	3251.4	30,890	181,910	248,640	3799.0	36,090	212,550	282,800	4321.0	41,050	241,750
11,400	216,600	3309.4	31,440	185,160	253,080	3866.9	36,735	216,345	287,850	4398.1	41,780	246,070
11,600	220,400	3367.5	31,990	188,410	257,520	3934.7	37,380	220,140	292,900	4475.3	42,515	250,385
11,800	224,200	3425.5	32,545	191,655	261,960	4002.6	38,025	223,935	297,950	4552.4	43,250	254,700
12,000	228,000	3483.6	33,095	194,905	266,400	4070.4	38,670	227,730	303,000	4629.6	43,980	259,020
12,200	231,800	3541.7	33,645	198,155	270,840	4138.2	39,315	231,525	308,050	4706.8	44,715	263,335
12,400	235,600	3599.7	34,195	201,405	275,280	4206.1	39,960	235,320	313,100	4783.9	45,445	267,655
12,600	239,400	3657.8	34,750	204,650	279,720	4273.9	40,600	239,120	318,150	4861.1	46,180	271,970
12,800	243,200	3715.8	35,300	207,900	284,160	4341.8	41,245	242,915	323,200	4938.2	46,915	276,285
13,000	247,000	3773.9	35,850	211,150	288,600	4409.6	41,890	246,710	328,250	5015.4	47,645	280,605

[1]If a regular tool joint is inserted every 90 ft. all values for 19.00-lb. drill pipe will be increased about 2.8 percent, for 22.20-lb. drill pipe about 2.2 percent, and for 25.25-lb. drill pipe about 1.9 percent.



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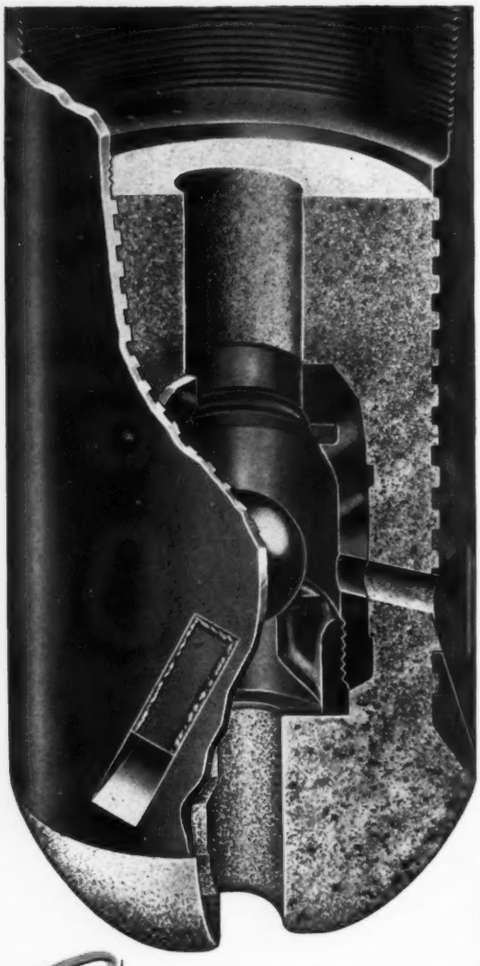
TOTAL[1] UPWARD PRESSURE AT WELL HEAD BETWEEN DRILL PIPE AND CASING, LB.

Casing diam., O.D., in.	Drill pipe diam., O.D., in.	Well head pressure, lb. per sq. in. gauge																	
		1000	2000	3000	3500	4000	4500	5000	5500	6000	6250	6500	6750	7000	7200	7400	7600	7800	8000
12	2⅜	97,350	194,710	292,060	340,740	389,420	438,090	486,770	535,450	584,120	608,460	632,800	657,140	681,480	700,950	720,420	739,890	759,360	778,830
	2⅞	95,290	190,580	285,880	333,520	381,170	428,810	476,460	524,110	571,750	595,580	619,400	643,220	667,040	686,100	705,160	724,220	743,280	762,340
	3½	92,160	184,33[illegible]	276,490	322,570	368,650	414,730	460,820	506,900	552,980	576,020	599,060	622,100	645,140	663,570	682,010	700,440	718,870	737,300
	4½	85,880	171,760	257,640	300,580	343,520	386,460	429,400	472,340	515,280	536,750	558,220	579,690	601,160	618,340	635,510	652,690	669,860	687,040
	5⅛	77,480	154,960	232,430	271,170	309,910	348,650	387,390	426,130	464,870	484,240	503,610	522,980	542,350	557,840	573,340	588,830	604,330	619,820
	6⅝	67,310	134,620	201,940	235,590	269,250	302,900	336,560	370,220	403,870	420,700	437,530	454,360	471,180	484,650	498,110	511,570	525,030	538,500
	7⅝	56,120	112,240	168,360	196,420	224,480	252,540	280,600	308,660	336,720	350,750	364,780	378,810	392,840	404,060	415,290	426,510	437,740	448,960
	8⅝	43,360	86,720	130,070	151,750	173,430	195,110	216,790	238,470	260,150	270,990	281,830	292,670	303,510	312,180	320,850	329,520	338,190	346,860
13	2⅜	117,070	234,150	351,220	409,760	468,300	526,830	585,370	643,910	702,440	731,710	760,980	790,250	819,520	842,930	866,350	889,760	913,180	936,590
	[illegible]⅞	115,010	230,020	345,040	402,540	460,050	517,550	575,060	632,570	690,070	718,820	747,580	776,330	805,080	828,090	851,090	874,090	897,090	920,100
	3½	111,880	223,770	335,650	391,590	447,530	503,470	559,420	615,360	671,300	699,270	727,240	755,210	783,180	805,560	827,930	850,310	872,690	895,060
	4½	105,600	211,200	316,800	369,600	422,400	475,200	528,000	580,800	633,600	660,000	686,400	712,800	739,200	760,320	781,440	802,560	823,680	844,800
	5⅛	97,200	194,400	291,590	340,190	388,790	437,390	485,990	534,590	583,190	607,490	631,790	656,090	680,390	699,830	719,270	738,700	758,140	777,580
	6⅝	87,030	174,060	261,100	304,610	348,130	391,640	435,160	478,680	522,190	543,950	565,710	587,470	609,220	626,630	644,040	661,440	678,850	696,260
	7⅝	75,840	151,680	227,520	265,440	303,360	341,280	379,200	417,120	455,040	474,000	492,960	511,920	530,880	546,050	561,220	576,380	591,550	606,720
	8⅝	63,080	126,160	189,230	220,770	252,310	283,850	315,390	346,930	378,470	394,240	410,010	425,780	441,550	454,160	466,780	479,390	492,010	504,620
13⅜	2⅜	122,550	245,090	367,640	428,910	490,190	551,460	612,740	674,010	735,280	765,920	796,560	827,190	857,830	882,340	906,850	931,360	955,870	980,380
	2⅞	120,480	240,970	361,460	421,700	481,940	542,180	602,420	662,670	722,910	753,030	783,150	813,270	843,400	867,490	891,590	915,690	939,780	963,880
	3½	117,360	234,710	352,070	410,750	469,420	528,100	586,780	645,460	704,140	733,480	762,810	792,150	821,490	844,960	868,430	891,910	915,380	938,850
	4½	111,070	222,150	333,220	388,760	444,290	499,830	555,360	610,900	666,440	694,210	721,970	749,740	777,510	799,730	821,940	844,150	866,370	888,580
	5⅛	102,670	205,340	308,010	359,350	410,680	462,020	513,360	564,690	616,030	641,690	667,360	693,030	718,700	739,230	759,770	780,300	800,830	821,370
	6⅝	92,500	185,010	277,520	323,770	370,020	416,270	462,530	508,780	555,030	578,160	601,280	624,410	647,540	666,040	684,540	703,040	721,540	740,040
	7⅝	81,310	162,630	243,940	284,600	325,250	365,910	406,560	447,220	487,880	508,210	528,530	548,860	569,190	585,450	601,720	617,980	634,240	650,500
	8⅝	68,550	137,100	205,650	239,930	274,200	308,480	342,760	377,030	411,310	428,440	445,580	462,720	479,860	493,570	507,280	520,990	534,700	548,410
14	2⅜	135,420	270,840	406,260	473,970	541,680	609,390	677,100	744,810	812,520	846,380	880,230	914,080	947,940	975,020	1,002,110	1,029,190	1,056,280	1,083,360
	2⅞	133,360	266,720	400,070	466,750	533,430	600,110	666,790	733,470	800,150	833,490	866,830	900,170	933,510	960,180	986,850	1,013,520	1,040,190	1,066,860
	3½	130,230	260,460	390,690	455,800	520,920	586,030	651,140	716,260	781,370	813,930	846,490	879,050	911,600	937,650	963,690	989,740	1,015,790	1,041,830
	4½	123,950	247,890	371,840	433,810	495,780	557,760	619,730	681,700	743,680	774,660	805,650	836,640	867,620	892,410	917,200	941,990	966,780	991,570
	5⅛	115,540	231,090	346,630	404,400	462,180	519,950	577,720	635,490	693,260	722,150	751,040	779,920	808,810	831,920	855,030	878,130	901,240	924,350
	6⅝	105,380	210,760	316,130	[illegible]68,820	421,510	474,200	526,890	579,580	632,270	658,610	684,960	711,300	737,650	758,720	779,800	800,870	821,950	843,020
	7⅝	94,190	188,370	282,560	329,650	376,740	423,840	470,930	518,020	565,120	588,660	612,210	635,760	659,300	678,140	696,980	7[illegible]5,810	734,650	753,490
	8⅝	81,420	162,850	244,270	284,980	325,700	366,410	407,120	447,830	488,540	508,900	529,260	549,610	569,970	586,250	602,540	618,820	635,110	651,390
16	2⅜	181,230	362,460	543,690	634,310	724,920	815,540	906,160	996,770	1,087,390	1,132,690	1,178,000	1,223,310	1,268,620	1,304,860	1,341,110	1,377,360	1,413,600	1,449,850
	2⅞	179,170	358,340	537,510	627,090	716,680	806,260	895,840	985,430	1,075,010	1,119,810	1,164,600	1,209,390	1,254,180	1,290,020	1,325,850	1,361,680	1,397,520	1,433,350
	3½	176,040	352,080	528,120	616,140	704,160	792,180	880,200	968,220	1,056,240	1,100,250	1,144,260	1,188,270	1,232,280	1,267,490	1,302,700	1,337,900	1,373,110	1,408,320
	4½	169,760	339,510	509,270	594,150	679,030	763,910	848,780	933,660	1,018,540	1,060,980	1,103,420	1,145,860	1,188,300	1,222,250	1,256,200	1,290,150	1,324,100	1,358,060
	5⅛	161,360	322,710	484,060	564,740	645,420	726,100	806,780	887,450	968,130	1,008,470	1,048,810	1,089,150	1,129,480	1,161,760	1,194,030	1,226,300	1,258,570	1,290,840
	6⅝	151,190	302,380	453,570	529,160	604,760	680,350	755,940	831,540	907,130	944,930	982,730	1,020,530	1,058,320	1,088,560	1,118,800	1,149,040	1,179,270	1,209,510
	7⅝	140,000	279,990	419,990	489,990	559,990	629,990	699,980	769,980	839,980	874,980	909,980	944,980	979,980	1,007,980	1,035,980	1,063,980	1,091,980	1,119,980
	8⅝	127,240	254,470	381,700	445,320	508,940	572,560	636,180	699,790	763,410	795,220	827,030	858,840	890,640	916,090	941,540	966,990	992,430	1,017,880

The fact that total well head pressures for unit pressures as high as 8000 lb. per sq. in. are included in the table should not be interpreted as indicating that the casing will have sufficient bursting strength to withstand such pressure. For bursting strength of casing see Table P432.2, p. 257, August, 1937, issue.

[1]Total for lightest weight casing, hence a maximum for each size casing.



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ON YOUR NEXT JOB USE A BAKER CEMENT WASH-DOWN WHIRLER FLOAT SHOE (Or Wash-Down Whirler Guide Shoe . . . this new principle is available in both types) . . . YOU'LL LIKE THE RESULTS.

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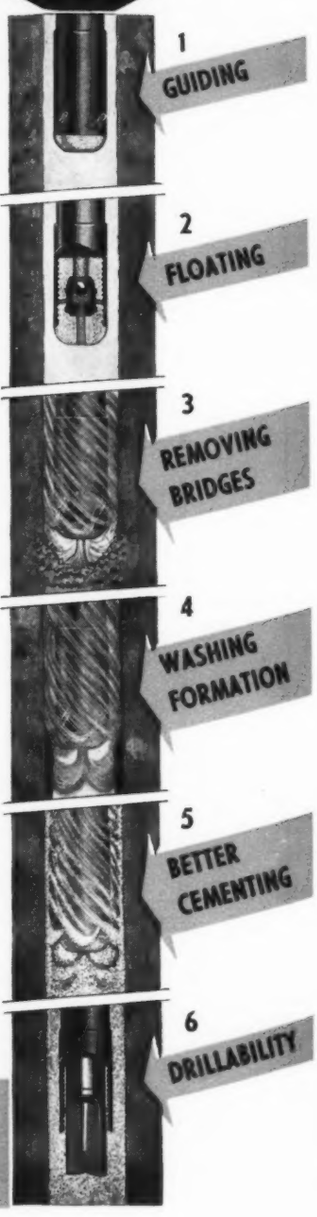
Send For New ILLUSTRATED FOLDER DO IT Now!

1. **GUIDING** is easily and efficiently done, due to the rounded nose of the concrete guide which leads the casing past all side wall irregularities . . .
2. **FLOATING** is safely performed due to the "BALL TYPE" Back-Pressure Valve which provides a leak-proof seal against either high or low pressure and affords strength beyond the collapsing point of the casing . . .
3. **REMOVING BRIDGES** and **WASHING DOWN** is accomplished by the downward, hydraulicking action of the circulating fluid through the baffled "Down-Whirler" ports . . .
4. **WASHING FORMATION** at the cementing point to condition the hole preparatory to cementing, is another Result . . .
5. **BETTER CEMENTING** is accomplished by the definite DOWNWARD as well as the UPWARD whirling action imparted to the cement in its travel around the shoe and up and around the casing . . . this action insures best possible encasement of the pipe with a uniform body of cement - - - little danger of channelling here!
6. **DRILLABILITY** is always assured when you have only "Baker-Formula" Concrete and a minimum amount of Bakelite to drill up into small, harmless fragments that circulate out of the hole.



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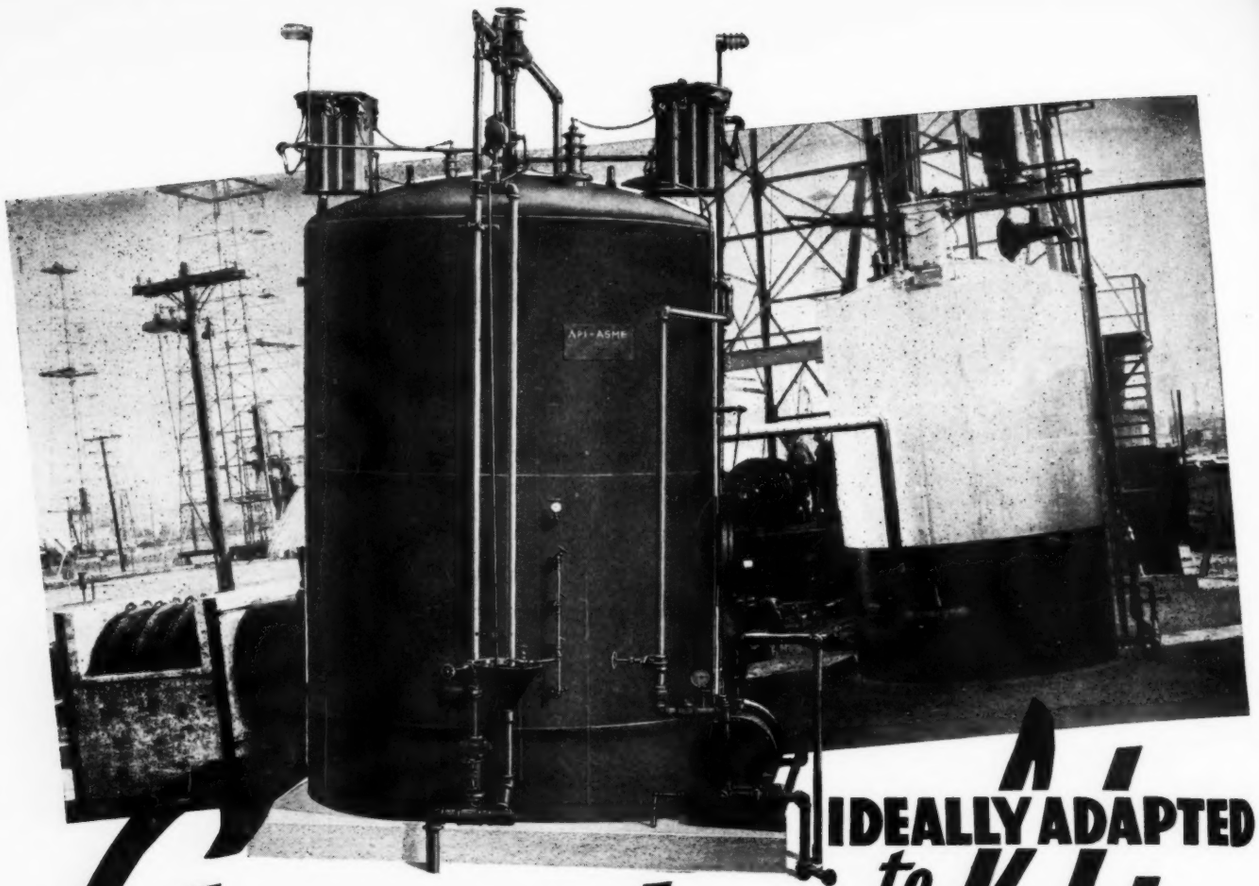
INDICATED COMPRESSOR HORSEPOWER REQUIRED TO COMPRESS ONE MILLION CU. FT. OF NATURAL GAS PER 24-HR. DAY

Discharge pressure, lb. per sq. in. gauge	Intake pressure, lb. per sq. in. gauge																		
	0	10	20	30	40	50	60	70	80	90	100	120	140	160	180	200	250	300	350	400
25	55	34	19																	
50	85	55	40	30	20															
75	106	72	55	43	34	28	22	17												
100	119	87	68	54	45	38½	33	27	22½	17½										
125	130	99	79	64½	54	47	41	35	31½	26½	20½	13½								
150	139	110	88½	73	62	54½	47½	42	38	33	28½	21½	14½							
175	146½	117½	97	81	69	61½	54	48½	44	39½	35	28	20½	15½						
200	153	123½	105	88½	76	68	60	54	49	45	40½	33½	26	20½	16½					
225	159	129	111	95	82½	74	65½	59½	54½	49½	45½	38	31	25½	21	16½				
250	165	134½	116½	101	88½	79½	70½	65	59	54½	50	42½	35½	30½	25½	20½				
275	170½	139	121½	106½	94½	85	76	69½	63½	58½	54	46½	39½	34½	30	24½	15½			
300	176	143½	125½	111½	99½	90	80½	73½	67½	62½	58	50½	43½	38½	33½	28½	18½			
325	181	147½	129½	116	104	94½	85½	78	72	66½	62	54	47	42	37	32	22	15		
350	185½	151½	133	119½	108	99	89½	82	75½	70	65	57½	50	45	40	35½	25	18		
375	190	155	136½	123	112	103	94	85½	79½	73	68½	60½	53	48	43	38½	28	20½	14½	
400	194	158	140	126½	116	107	97½	89	83	76½	71½	63½	56	51	46	41½	31	23	17	
425	197½	161½	143	130	119½	110	101½	92½	86½	80	75	67	59	54	49	44	34	25½	19½	14
450	200½	164½	146	133	122½	113	105	96	89½	83	78	70	62	56½	51	46½	36½	28	21½	16½
475	203	167½	148½	135½	125	116	108	99	93	86	81	72½	64½	59	53½	49	39½	30½	24	18½
500	205½	170	151	138	127½	118½	110½	102	96	89	84	75	67	61½	56	51½	42	33	26	20½
525	208	173	153½	140½	130	121	113½	105	99	92	87	77½	69½	63½	58½	54	44	35	28½	22½
550	210	175½	156	143	132½	123½	116	108	102	95	89½	80	72	66	61	56	46	37½	30½	24½
575	212	178	158½	145	134½	126	118½	111	104½	97½	92	82½	74½	68½	63	58	48	39½	32½	26½
600	214	180½	160½	147½	136½	128	120½	113½	107	100½	94½	85	76½	70½	65	60	50	41½	34	28½
625	216	183	163	149½	138½	130	122½	116	109½	103	97	87½	79	73	67	62	51½	43½	36	30½
650	217½	185½	165	151½	140	131½	124½	118	111½	105½	99½	89½	81	75	69	64	53½	45	38	32½
675	219	187½	167½	153½	142	133½	126½	120	113½	107½	102	92	83	77	71	66	55	47	40	34½
700	220½	190	169½	155½	144	135	128½	122	115½	110	104	94	85½	79	73	68	57	48½	41½	36
725	222	192	171½	157½	146	137	130½	124	117½	112	106	96	87½	81	75	69½	58½	50	43½	38
750	223½	194	173½	159	147½	138½	132	125½	119½	113½	107½	98	89½	82½	76½	71½	60	51½	45	39½
775	225	196	175½	161	149½	140½	134	127½	121	115½	109½	100	91½	84½	78½	73	61½	53	46½	41
800	226½	198	177½	162½	151	142	135½	129	123	117	111	102	93	86	80½	75	63	54½	48	42½
825	228	199½	179	164½	153	144	137	130½	125	118½	113	103½	95	88	82	77	65	56	49½	44
850	229½	201	181	166	154½	145½	138½	132	126½	120	114½	105½	97	89½	84	78½	66½	57½	51	45½

[1]Those interested in gas transmission may find it preferable to classify this table under P 624.2, whereas those interested in extraction of natural gasoline may prefer to classify it under P 772.3.



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Gas and air lift PRODUCTION

Although gas and air-lifting methods have a tendency to emulsify production, this fact need not deter producers from using such methods where conditions make them desirable.

Petreco Electromatic Dehydration is generally recognized as the most effective method for treating difficult gas lift emulsions. It is ideally adapted for handling gas lift production with either the automatic flow-line or tank treatment method.

Detailed data on Petreco Electroflow Dehydration will be supplied to present and potential users of air and gas lift production methods without obligation.

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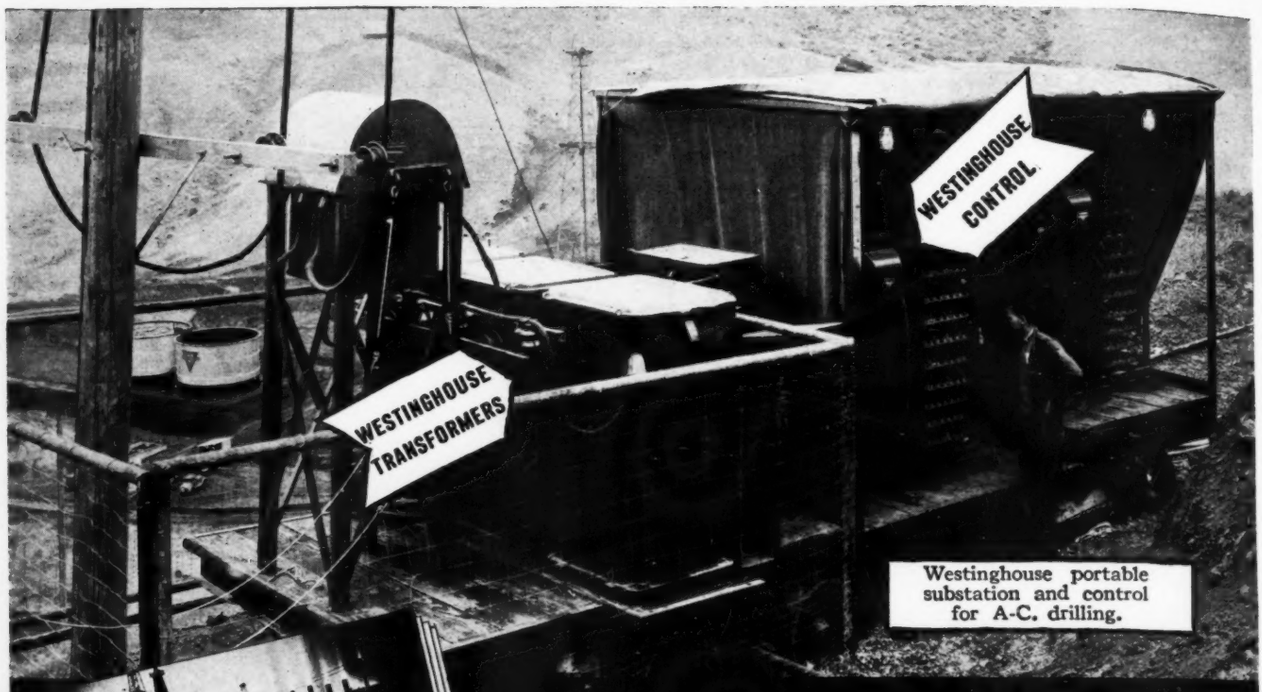
PETRECO
ELECTROFLOW DEHYDRATION

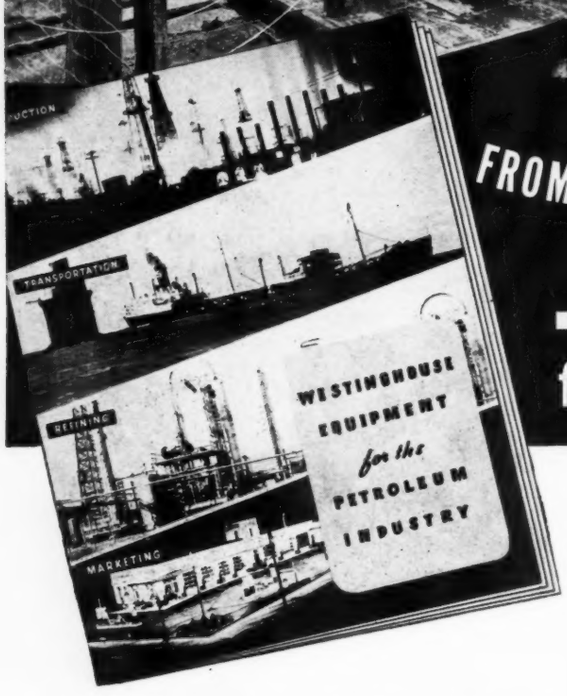
DIAMETER, MILS,[1] OF WIRE OF VARIOUS GAUGES

Gauge number	American wire gauge (Brown and Sharpe)	Steel wire gauge	Birmingham wire gauge (Stubs')	Old English wire gauge (London)	Stubs' steel wire gauge	(British) Standard wire gauge
0000000	.....	490.0	.....	.....	.....	500
000000	.....	461.5	.....	.....	.....	464
00000	.....	430.5	.....	.....	.....	432
0000	460	393.8	454	454	.....	400
000	410	362.5	425	425	.....	372
00	365	331.0	380	380	.....	348
0	325	306.5	340	340	.....	324
1	289	283.0	300	300	227	300
2	258	262.5	284	284	219	276
3	229	243.7	259	259	212	252
4	204	225.3	238	238	207	232
5	182	207.0	220	220	204	212
6	162	192.0	203	203	201	192
7	144	177.0	180	180	199	176
8	128	162.0	165	165	197	160
9	114	148.3	148	148	194	144
10	102	135.0	134	134	191	128
11	91	120.5	120	120	188	116
12	81	105.5	109	109	185	104
13	72	91.5	95	95	182	92
14	64	80.0	83	83	180	80
15	57	72.0	72	72	178	72
16	51	62.5	65	65	175	64
17	45	54.0	58	58	172	56
18	40	47.5	49	49	168	48
19	36	41.0	42	40	164	40
20	32	34.8	35	35	161	36
21	28.5	31.7	32	31.5	157	32
22	25.3	28.6	28	29.5	155	28
23	22.6	25.8	25	27.0	153	24
24	20.1	23.0	22	25.0	151	22
25	17.9	20.4	20	23.0	148	20
26	15.9	18.1	18	20.5	146	18
27	14.2	17.3	16	18.75	143	16.4
28	12.6	16.2	14	16.50	139	14.8
29	11.3	15.0	13	15.50	134	13.6
30	10.0	14.0	12	13.75	127	12.4
31	8.9	13.2	10	12.25	120	11.6
32	8.0	12.8	9	11.25	115	10.8
33	7.1	11.8	8	10.25	112	10.0
34	6.3	10.4	7	9.50	110	9.2
35	5.6	9.5	5	9.00	108	8.4
36	5.0	9.0	4	7.50	106	7.6
37	4.5	8.5	.....	6.50	103	6.8
38	4.0	8.0	.....	5.75	101	6.0
39	3.5	7.5	.....	5.00	99	5.2
40	3.1	7.0	.....	4.50	97	4.8
41	.....	6.6	.....	.....	95	4.4
42	.....	6.2	.....	.....	92	4.0
43	.....	6.0	.....	.....	88	3.6
44	.....	5.8	.....	.....	85	3.2
45	.....	5.5	.....	.....	81	2.8
46	.....	5.2	.....	.....	79	2.4
47	.....	5.0	.....	.....	77	2.0
48	.....	4.8	.....	.....	75	1.6
49	.....	4.6	.....	.....	72	1.2
50	.....	4.4	.....	.....	69	1.0

[1] 1 mil = 0.001 in.



Westinghouse portable substation and control for A-C. drilling.



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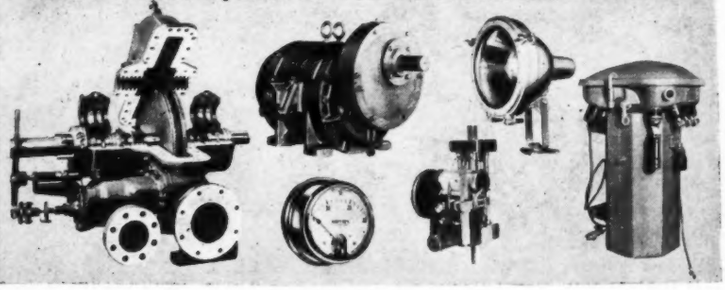
A FEW TYPICAL PRODUCTS FROM THE COMPLETE LINE OF WESTINGHOUSE EQUIPMENT FOR THE PETROLEUM INDUSTRY



VELOCITY[1] OF FLOW, FT. PER SEC., THROUGH 4-IN. TUBING

Rate of production, bbl. per day	Gas-oil ratio, cu. ft. per bbl.	Tubing pressure at casinghead, lb. per sq. in. gauge								
		0	25	50	75	100	125	150	175	200
50	1000	6.8	2.5	1.6	1.1	0.9	0.8	0.6	0.6	0.5
100		13.6	5.1	3.2	2.3	1.8	1.5	1.3	1.1	1.0
150		20.4	7.6	4.7	3.4	2.7	2.3	1.9	1.7	1.5
200		27.2	10.2	6.3	4.6	3.6	3.0	2.6	2.3	2.0
250		34.1	12.7	7.9	5.7	4.5	3.8	3.2	2.8	2.5
300		40.9	15.3	9.5	6.9	5.4	4.5	3.9	3.4	3.0
350		47.7	17.8	11.0	8.0	6.3	5.3	4.5	3.9	3.5
400		54.5	20.4	12.6	9.2	7.2	6.0	5.1	4.5	4.0
50	1250	8.5	3.2	2.0	1.4	1.1	0.9	0.8	0.7	0.6
100		17.0	6.3	3.9	2.9	2.2	1.9	1.6	1.4	1.2
150		25.5	9.5	5.9	4.3	3.4	2.8	2.4	2.1	1.9
200		34.0	12.7	7.8	5.7	4.5	3.7	3.2	2.8	2.5
250		42.5	15.9	9.8	7.1	5.6	4.6	4.0	3.5	3.1
300		51.0	19.0	11.8	8.6	6.7	5.6	4.8	4.2	3.7
350		59.5	22.2	13.7	10.0	7.9	6.5	5.6	4.9	4.3
400		68.0	25.4	15.7	11.4	9.0	7.4	6.3	5.6	4.9
50	1500	10.2	3.8	2.3	1.7	1.3	1.1	0.9	0.8	0.7
100		20.4	7.6	4.7	3.4	2.7	2.2	1.9	1.7	1.5
150		30.6	11.4	7.0	5.1	4.0	3.3	2.8	2.5	2.2
200		40.8	15.2	9.4	6.8	5.4	4.4	3.8	3.3	2.9
250		51.0	19.0	11.7	8.5	6.7	5.5	4.7	4.1	3.7
300		61.2	22.8	14.1	10.2	8.0	6.6	5.7	5.0	4.4
350		71.4	26.6	16.4	11.9	9.4	7.8	6.6	5.8	5.1
400		81.6	30.4	18.8	13.6	10.7	8.9	7.6	6.6	5.9
50	1750	11.9	4.4	2.7	2.0	1.6	1.3	1.1	1.0	0.8
100		23.8	8.9	5.5	4.0	3.1	2.6	2.2	1.9	1.7
150		35.7	13.3	8.2	5.9	4.7	3.9	3.3	2.9	2.5
200		47.6	17.7	10.9	7.9	6.2	5.2	4.4	3.8	3.4
250		59.5	22.1	13.7	9.9	7.8	6.4	5.5	4.8	4.2
300		71.3	26.6	16.4	11.9	9.3	7.8	6.6	5.7	5.1
350		83.2	31.0	19.1	13.9	10.9	9.1	7.7	6.7	5.9
400		95.1	35.4	21.8	15.8	12.5	10.4	8.8	7.7	6.8
50	2000	13.6	5.1	3.1	2.3	1.8	1.5	1.2	1.1	1.0
100		27.2	10.1	6.2	4.5	3.5	2.9	2.5	2.2	1.9
150		40.8	15.2	9.3	6.8	5.3	4.4	3.7	3.3	2.9
200		54.3	20.2	12.5	9.0	7.1	5.9	5.0	4.4	3.9
250		67.9	25.3	15.6	11.3	8.9	7.3	6.2	5.4	4.8
300		81.5	30.3	18.7	13.5	10.6	8.8	7.5	6.5	5.8
350		95.1	35.4	21.8	15.8	12.4	10.2	8.7	7.6	6.8
400		108.7	40.4	24.9	18.1	14.2	11.7	10.0	8.7	7.7
50	2250	15.3	5.7	3.5	2.5	2.0	1.6	1.4	1.2	1.1
100		30.6	11.4	7.0	5.1	4.0	3.3	2.8	2.4	2.2
150		45.8	17.0	10.5	7.6	6.0	4.9	4.2	3.7	3.2
200		61.1	22.7	14.0	10.1	8.0	6.6	5.6	4.9	4.3
250		76.4	28.4	17.5	12.7	10.0	8.2	7.0	6.1	5.4
300		91.7	34.1	21.0	15.2	11.9	9.9	8.4	7.3	6.5
350		106.9	39.8	24.5	17.7	13.9	11.5	9.8	8.5	7.6
400		122.2	45.4	28.0	20.3	15.9	13.1	11.2	9.8	8.7
50	2500	17.0	6.3	3.9	2.8	2.2	1.8	1.5	1.4	1.2
100		33.9	12.6	7.8	5.6	4.4	3.6	3.1	2.7	2.4
150		50.9	18.9	11.7	8.4	6.6	5.5	4.6	4.1	3.6
200		67.9	25.2	15.5	11.3	8.8	7.3	6.2	5.4	4.8
250		84.9	31.5	19.4	14.1	11.0	9.1	7.7	6.8	6.0
300		101.8	37.8	23.3	16.9	13.2	10.9	9.3	8.1	7.2
350		118.8	44.2	27.2	19.7	15.5	12.7	10.8	9.5	8.4
400		135.8	50.5	31.1	22.5	17.7	14.6	12.4	10.8	9.6

[1]Solution and condensation under pressure are not considered; hence the values are maxima.

ON THE FINEST OIL FIELD MACHINERY

Fred E. Cooper—Allis-Chalmers
Model L Mobile Winch Tractor uses 4 installations of DIAMOND Roller Chain 1¾" pitch double-strand on winch drive, and two installations of DIAMOND Chain 1¾" pitch single-strand on the wheel drive.

Biggest Tractor Type Pulling Unit Handles Tubing to 8500 Ft.

This giant servicing unit is the answer to the increasing demand for *mobile* equipment which will handle tubing up to 8500 feet.

The tremendous power required to handle the great weight of tubing for deep wells, and the nearly 8 miles of half-inch sand line put great responsibility on the roller chains. But Fred E. Cooper's 20 years of experience have given him ample proof of the reserve capacity and uniformity of DIAMOND Roller Chains with which this giant unit is equipped.

DIAMOND CHAIN & MFG. CO.
441 Kentucky Ave., Indianapolis, Ind. **Tulsa, Okla.: 227 East 29th St.**

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ROLLER CHAIN